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Can Dual Mobility Cups prevent Dislocation in All Situations After Revision Total Hip Arthroplasty?

Julien Wegrzyn, MD, PhD [a,b], Eloïse Tebaa, MD [a], Alexandre Jacquel, MD [a], Jean-Paul Carret, MD [a], Jacques Béjui-Hugues, MD [a], Vincent Pibarot, MD [a]

[a] *Department of Orthopedic Surgery—Pavillon T, Hôpital Edouard Herriot, Lyon, France*
[b] *INSERM UMR 1033, Université de Lyon, Lyon, France*

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ABSTRACT

The outcome of a single design of dual mobility cup was prospectively evaluated in a continuous series of 994 revision THAs with respect to dislocation and intra-prosthetic dislocation (IPD). At a 7.3-year mean follow-up, the dislocation rate was 1.5% and the IPD rate was 0.2%. The 2 IPD occurred in acetabular-only revisions and were related to a poor head-to-neck ratio with early impingement and wear at the polyethylene mobile component chamfer. Dual mobility cups demonstrated a low dislocation rate in revision THA but did not compensate for potential perioperative technical errors. In addition, IPD did not appear to be a concern with respect to the benefit in term of instability prevention though caution is advised in acetabular-only revision associated with a poor head-to-neck ratio. Level of Evidence: Therapeutic study—Level IV

Instability represents the leading cause of failure in revision total hip arthroplasty (rTHA) accounting for up to 35% of these failures [1,2]. The cause of dislocation after revision is related to multiple factors such as patient characteristics, revision etiology, component orientation, location of the hip center of rotation, limb length and status of the hip abductor mechanism [1–4]. In an attempt to stabilize the hip, several options for the acetabular reconstruction have been proposed including constrained acetabular components, large femoral heads and dual mobility cups. The rational of constrained components is to prevent instability by constraining the femoral head into a polyethylene (PE) liner and restricting hip range of motion. However, such a mechanism may result in high stress applied to the bone–implant interface leading to loosening and impingement at the PE liner rim leading to locking ring damages and subsequent dislocation [5–7]. Therefore, with a 10-year failure rate up to 42.1%, many authors advocated limiting their use to salvage situation of recurrent instability [5–7]. With the improvement in highly cross-linked PE (XLPE), large femoral heads have emerged with the rational of increasing the head-to-neck ratio to prevent instability [8]. In a short-term follow-up randomized trial, Garbuz et al [8] demonstrated that large femoral head of 36- or 40-mm reduced significantly the dislocation rate to 1.1% versus 8.7% with 32-mm head. Used in Europe for more than 25 years, dual mobility cups have demonstrated effectiveness to prevent instability with dislocation rates ranging from 0% to 8.7% in rTHA [2,9–14]. However, these encouraging results were mostly based on retrospective series including a limited number of patients with various designs and generations of implants [9–14]. In addition, concerns were raised due to the risk of intra-prosthetic dislocation (IPD) although the rate of IPD was low in literature reported from 0.28% to 1% [15–17].

Therefore, the current series prospectively evaluated the outcome of a single dual mobility cup in rTHA with respect to dislocation and IPD rates at mid- to long-term follow-up. The purpose of this study was (1) to demonstrate the effectiveness of a dual mobility cup to prevent instability in a large, prospective and continuous series of rTHA and (2) to analyze the cases of dislocation or IPD to determine the mechanisms of failure. We hypothesized that dual mobility cups could prevent dislocation after rTHA and that IPD is not a concern with respect to the benefit in term of instability prevention.

Patients and Methods

From January 2000 to December 2011, a continuous series of 1178 patients (1219 hips) who have undergone a rTHA associated with acetabular reconstruction using a dual mobility cup was prospectively included in our institutional Total Joint Registry (TJR). Exclusion criteria were revision performed in the case of bone tumors, with a different acetabular component and femoral-only revision. Owing to the French regulation, patient's informed consent was not required to be included in this study. At the time of evaluation, 139 patients (159 rTHA, mean follow-up = 3.1 years [0.2–11 years]) died of causes unrelated to revision. In addition, 59 patients (66 rTHAs, mean follow-up = 2.4 years [1–8 years]) were lost to follow-up due to failure to return for the post-operative evaluation and no response to phone calls or letters. In

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Reprint requests: Julien Wegrzyn, MD, PhD, Department of Orthopedic Surgery—Pavillon T, Hôpital Edouard Herriot, 5, place d'Arsonval, 69437 Lyon, France.

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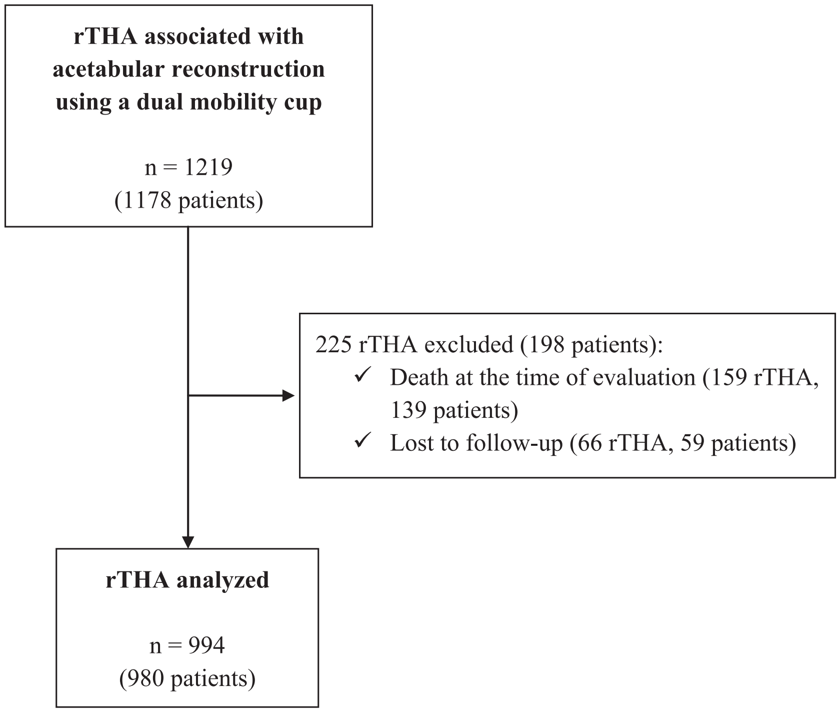

Fig. 1. Study flow diagram of the rTHA and patients.

these 198 patients (225 rTHAs), no dislocation was reported at the latest follow-up available. However, one of deceased patient underwent IPD 13 months after an acetabular-only revision for instability as previously reported by Guyen et al [10]. This 84-year-old patient with Parkinson's disease was re-operated for a Girdlestone procedure and died at 3 months [10]. Therefore, a continuous series of 980 patients (994 rTHAs, 568 women, 412 men, mean age at the time of the revision = 70 years [39–92 years]) was included and analyzed in this study (Fig. 1). The mean follow-up of the 994 rTHAs was 7.3 years (2–13 years). Among the 994 rTHAs, 576 (58%) were acetabular-only revisions and 418 (42%) acetabular and femoral revisions. Etiologies for revision were aseptic loosening in 739 cases (74%), periprosthetic infection in 173 cases (17%), instability in 68 cases (7%), and periprosthetic fracture in 14 cases (2%). In addition, the rTHA included was the first revision in 795 cases (80%), the second in 159 cases (16%), the third in 30 cases (3%) and the forth or more in 10 cases (1%).

All revisions were performed through a posterolateral approach by or under the supervision of two senior surgeons. The acetabular reconstruction was systematically performed using a single M30NW dual mobility cup (Saturne®, Amplitude, Valence, France) with a 22.2-mm cobalt–chrome femoral head impacted in force and captured into an ultra-high molecular weight PE mobile component using a snap-fit technique (Fig. 2A and B) [18]. After acetabular component removal and granulomatous tissue debridement, occurrence of acetabular bone deficiency was addressed and graded according to the 4-grade classification of the AAOS [19]. In 695 rTHAs (70%), no acetabular bone defect or AAOS grade I and II defects were reported and a cementless hydroxyapatite-coated dual mobility cup was used. In 218 rTHAs (21.9%) with AAOS grade III and IV defects, an acetabular reconstruction using a dual mobility cup cemented into a 316 L stainless steel Kerboull cross-plate (Amplitude, Valence, France) associated with structural bone graft was performed according to the technique described by Wegrzyn et al [20]. In 74 rTHAs (7.4%) with AAOS grade IV defect, the acetabular reconstruction was performed using a dual mobility cup cemented into a titanium Burch-Schneider cage (Zimmer, Warsaw, IN) in 69 cases and into a porous tantalum revision shell (TMARS®, Zimmer, Warsaw, IN) in 5 cases. In 7 rTHAs (0.7%), the acetabular revision consisted in the cementation of a dual mobility cup into a well-fixed metal-back according to the technique described by Wegrzyn et al [21]. Polymethylmethacrylate bone cement with 0.5 g of gentamicin (Palacos®R + G, Heraeus Medical GmbH, Wehrheim, Germany) was used. After 3.5 min of manual mixing at controlled-operating room

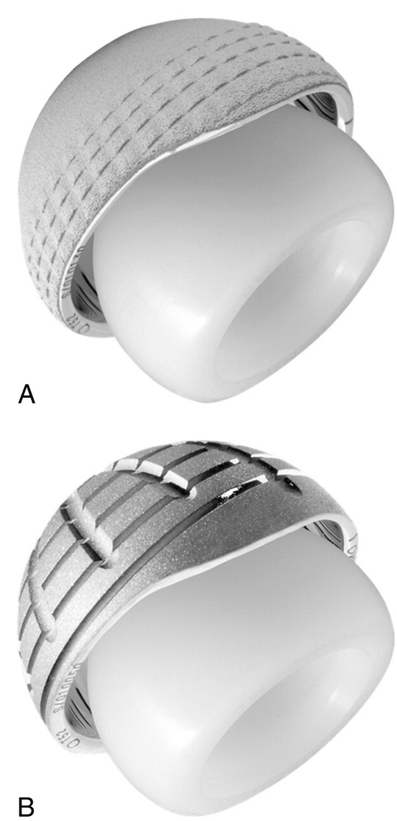

Fig. 2. The Saturne® dual mobility cup. (A) Cementless hydroxyapatite-coated implant. (B) Cemented implant with microblasted-finished hemispherical grooves for cement interdigitation.

temperature (18–20 °C) and humidity (40%–50%), a doughy texture of the cement was obtained. Then, the cement was thickly applied into the reinforcement device or the shell. The dual mobility cup was placed into the construct using manual pressure and centralization with particular attention to ensure a 2- to 3-mm uniform thickness of the cement mantle around the dual mobility cup [20,21]. Less than 1 mm of eccentricity was allowed [20,21].

On the femoral side, a cementless fully hydroxyapatite-coated titanium or a cemented stainless steel femoral stem was used in 379 rTHAs at the surgeon's discretion according the bone quality and structural integrity. A cementless titanium modular megaprosthesis for proximal femoral reconstruction arthroplasty (PP system®, Tornier, Montbonnot Saint Martin, France) was used for Paprosky type III and IV femoral bone defect in 37 rTHAs [22,23]. In two patients with a Paprosky type IV bone defect, one related to a femoral aseptic loosening of an ipsilateral THA and hinged total knee arthroplasty in a patient with rheumatoid arthritis and one related to severe osteolysis due to a chronic periprosthetic infection, a total femoral arthroplasty was performed using a bi-articular modular tumoral megaprosthesis (OSS®, Biomet, Warsaw, IN) [24]. Post-operative structured physical therapy with full weight-bearing was begun the day after surgery. For patients in whom complex acetabular and/or femoral reconstruction requiring bone graft was performed, partial weight bearing was prescribed during 6 weeks post-operatively and full weight-bearing thereafter.

Patients returned for post-operative follow-up visits at 6 weeks, 3 months, 6 months, 1 year and yearly thereafter. Patients underwent a clinical examination by the operating surgeon and plane anteroposterior and lateral radiographs of the pelvis and the operated hip were obtained. In case of inability to attend to the yearly visit, patients were contacted by phone calls. The occurrence of dislocation or IPD was systematically reported in our institutional TJR. Then, the database has been questioned to isolate each of these cases which were analyzed to determine the etiology, risk factors, occurrence of perioperative technical error during revision, and management of the dislocation or IPD as well as their recurrence at latest follow-up. In addition, a computed-tomography (CT-scan) evaluation was systematically performed after the second dislocation in order to diagnose a potential technical error such as implant malposition. Then, 2 groups of patients were defined according to the occurrence of a perioperative technical error (i.e. acetabular component malposition, major leg length discrepancy $\geq$2 cm and hip abductor mechanism malfixation) or not (i.e. early dislocation less than 2 months after revision and multiple hip surgery potentially associated with hip abductor deficiency). Finally, cases of IPD were reported according to the classification proposed by Philippot et al [15]. Data are presented as mean and range (min to max). Qualitative variables were compared using a chi-square test with a level of significance set at $P < 0.05$.

Results

Fifteen patients (10 women, 5 men, mean age at the time of the revision = 72 years [49–92 years]) who underwent dislocation were identified in our TJR. Therefore, over a 12-year period and a 7.3-year mean follow-up, the dislocation rate of rTHA using a dual mobility cup was 1.5% (15/994 revisions). With a dislocation rate of 1.6% (9/576 revisions) and 1.4% (6/418 revisions), there was no significant difference between acetabular-only revisions and both component revisions respectively ($P = 0.9$). In this series of 15 patients, the meantime between the revision and the first dislocation averaged 52 days (8–276 days) and the dislocation events averaged 1.7 (1–3 dislocations) (Tables 1 and 2). No recurrence of the dislocation was reported after appropriate management at a mean follow-up of 53 months (2–129 months).

Five rTHAs dislocated with identified technical error as reported in Table 1. Three of these 5 cases required reoperation in order to stabilize the hip (Table 1). In case #1, the technical error was a dual mobility cup malposition which required iterative acetabular revision for implant reorientation associated with abduction bracing during 3 months (Table 1). In case #2, the technical error was a post-operative leg length discrepancy with a 3-cm limb shortening in a patient with hemiparesis. Iterative femoral revision with a 2-cm lengthening of the modular femoral metaphysis prosthesis was performed and associated with abduction bracing during 3 months (Table 1). In 3 cases (cases #3–5), the technical error was a malfixation of the abductor mechanism (Table 1). In case #3, resection of the proximal femur for periprosthetic femoral fracture nonunion associated with major PE-related granuloma of the greater trochanter was performed during the femoral revision without stable fixation of the remaining abductor mechanism onto the prosthetic femoral metaphysis (Table 1) (Fig. 3A). The acetabular revision consisted in cementation of a dual mobility cup into a well-fixed metal-back (Fig. 3B). In order to stabilize the hip, an iterative acetabular revision was performed using an all-PE constrained acetabular component (Lefevre's Cup®, Lépine, Genay, France) cemented into a Kerboull cross-plate associated with abduction bracing during 3 months (Table 1) (Fig. 3C). Two cases (cases #4 and 5) did not require further surgery after closed reduction under general anesthesia (GA) and abduction bracing during 3 months (Table 1).

Ten rTHAs dislocated without identified technical error as reported in Table 2. Four of these cases (cases #6–9) were early dislocations occurring within two months after revision and did not require further surgery after closed reduction under GA and non-hinged knee bracing (Zimmer knee brace) during 3 weeks (Table 2). The 6 other cases (cases #10–15) were dislocations occurring in the context of multiple hip surgery associated with potential hip abductor mechanism deficiency (Table 2). Cases #10–12 did not require further surgery after closed reduction under GA and abduction bracing during 3 months whereas case #13 required an open reduction for non-reducible dislocation (Table 2). In case #14, 3 dislocation events occurred after mobile bearing exchange of the dual mobility cup for IPD related to PE chamfer wear (Table 2) (Fig. 4). Consequently, an iterative acetabular revision using a constrained acetabular component (Lefevre's cup) cemented into the well-fixed metal-back of the dual mobility cup was performed. In case #15, an acetabular reconstruction using a dual mobility cup cemented in a Kerboull cross-plate was associated with a total femoral arthroplasty using a bi-articular modular tumoral megaprosthesis for femoral aseptic loosening of an ipsilateral THA and TKA in a patient with severe rheumatoid arthritis (Table 2) (Fig. 5A, B). This case required an iterative acetabular revision with cementation of a constrained acetabular component (Lefevre's cup) in the Kerboull cross-plate followed by abduction bracing for 3 months (Table 2) (Fig. 5C).

In addition, 2 IPDs were identified in our TJR. Therefore, over a 12-year period and a mean follow-up of 7.3 years, the IPD rate of rTHA using a dual mobility cup was 0.2% (2/994 revisions). The first case of IPD was previously reported by Guyen et al [10] and occurred 35 months months after a unipolar acetabular revision for instability in a very active 58-year-old man. The second case corresponded to case #9 and occurred 9 years after an acetabular-only revision for instability (Table 2) (Fig. 4). In these 2 cases of acetabular-only revision, a cementless femoral stem with a 12/14 Morse taper was retained, and a 22.2-mm cobalt–chrome femoral head was inserted responsible for a poor head-to-neck ratio. Therefore, early impingement and wear at the chamfer of the mobile PE component leading to dislocation at the inner bearing was observed at the time of the revision. Since no loosening or arthrofibrosis was observed, these 2 cases were IPD type 1 according to the classification proposed by Philippot et al [15].

Discussion

Dual mobility cups have gained worldwide attention as an option in the prevention and treatment of instability particularly in rTHA [2]. Indeed, several European studies reported that dual mobility cups could offer the benefit of increased stability without compromising clinical outcomes and implant fixation durability [2,9–14,16,17]. However, most of these studies were retrospective and/or included a limited

Table 1
Cases of Dislocation After rTHA With Identified Perioperative Technical Error.

Case # (Gender, Age at rTHA)	Indication for Revision	Type of Revision	Type of Implants	Number of Dislocation	Risk Factors for Dislocation	Treatment of the Dislocation	Recurrence of the Dislocation at Latest FU
Implant malposition							
1 (♀, 80 yrs)	Chronic periprosthetic infection	Two-stage rTHA (left hip)	Dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect) and standard cementless femoral stem	2 posteriors (65 and 67 days after rTHA)	- Age >75 years - Lack of anterversion of the cemented dual mobility cup (15° vs. 26° on the sound contralateral hip)	- Iterative acetabular revision with reorientation of the cemented dual mobility cup into the cage - Abduction bracing during 3 months	No 83 months FU
Major leg length discrepancy ≥2 cm							
2 (♂, 49 yrs)	Aseptic loosening	Both component revision (right hip)	Cementless dual mobility cup and proximal femoral megaprosthesis	1 posterior (86 days after rTHA)	- Hemiparesis due to a cerebral stroke (operated limb) - 3 cm-shortening of the operated limb	- Iterative femoral rTHA with 2 cm lengthening of the modular femoral metaphysis prosthesis - Abduction bracing during 3 months	No 129 months FU
Abductor mechanism malfixation							
3 (♂, 92 yrs)	Failed ORIF of a Vancouver B1 femoral fracture (femoral nonunion) (Fig. 3A, B, C)	Both component revision (left hip)	Dual mobility cup cemented in a well-fixed metal back and proximal femoral megaprosthesis	3 posteriors (15, 17 and 29 days after rTHA)	- Extreme age - Large resection of the proximal third of the femur including the greater trochanter (femoral nonunion associated with major PE-related greater trochanter granuloma) during the femoral revision without stable fixation of the remaining abductor mechanism onto the modular femoral metaphysis prosthesis	- Iterative acetabular rTHA using a constrained all-PE liner cemented in a Kerboull cross-plate - Abduction bracing during 3 months	No 32 months FU

4 (♂, 73 yrs)	Chronic periprosthetic infection	Two-stage rTHA (third revision, left hip)	Dual mobility cup cemented in Kerboull cross-plate (AAOS stade III bone defect) and proximal femoral megaprosthesis	2 posteriors (29 and 44 days after rTHA)	- Age >70 years - Multiple hip surgery: ORIF of a bicolumn acetabular fracture in 1969, cementless THA for post-traumatic OA in 1977, first both component rTHA for aseptic loosening in 1984, ORIF of a Vancouver B1 femoral fracture in 1995, second acetabular rTHA for instability in 2005 - Resection of the proximal third of the femur without conservation of the greater trochanter during the current revision	- Closed reduction under GA - Abduction bracing during 3 months	No 29 months FU
5 (♀, 79 yrs)	Aseptic loosening	Both component revision (right hip)	Dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect) and proximal femoral megaprosthesis	2 posteriors (8 and 22 days after the surgical management of the acute periprosthetic infection)	- Age >70 years - Severe erosive rheumatoid arthritis - Multiple hip surgery: cemented Charnley-THA in 1978, first both component rTHA for aseptic loosening in 1999, second both component rTHA for aseptic loosening in 2010 (current revision) with resection of the proximal third of the femur without conservation of the greater trochanter (major PE-related granuloma and nonunion of the greater trochanter) and acetabular reconstruction using a dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect) - Debridement, lavage and mobile bearing exchange for acute periprosthetic infection in 2011	- Closed reduction under GA - Abduction bracing during 3 months	No 15 months FU

Table 2
Cases of Dislocation After rTHA Without Perioperative Technical Error.

Case # (Gender, Age at rTHA)	Indication for Revision	Type of Revision	Type of Implants	Number of Dislocation	Risk Factors for Dislocation	Treatment of the Dislocation	Recurrence of the Dislocation at Latest FU
Early dislocation (<2 months)							
6 (♂, 77 yrs)	Aseptic loosening	Acetabular-only revision (left hip)	Cementless dual mobility cup	1 posterior (30 days after rTHA)	Age >70 years	Closed reduction under GA[a]	No 66 months FU
7 (♀, 63 yrs)	Aseptic loosening	Acetabular-only revision (right hip)	Cementless dual mobility cup	1 posterior (27 days after rTHA)	ASA III (cardio-vascular disease: double-bypass for myocardial infarction and left-ventricular aneurysm)	Closed reduction under GA[a]	No 37 months FU
8 (♂, 53 yrs)	Aseptic loosening	Acetabular-only revision (right hip)	Cementless dual mobility cup	1 posterior (48 days after rTHA)	No	Closed reduction under GA[a]	No 94 months FU
9 (♀, 80 yrs)	Instability	Acetabular-only revision (right hip)	Cementless dual mobility cup	2 posteriors (15 and 58 days after rTHA)	- Age >75 years - Poliomyelitis (operated limb)	Closed reduction under GA[a]	No 99 months FU
Multiple hip surgery							
10 (♀, 49 yrs)	Aseptic loosening	Acetabular-only revision (second revision, left hip)	Dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect)	1 posterior (32 days after rTHA)	- ORIF of a bicolumn acetabular fracture in 1985 - Cementless THA for post-traumatic femoral head osteonecrosis in 1987 - First both component rTHA for aseptic loosening in 2001	- Closed reduction under GA - Abduction bracing during 3 months	No 70 months FU
11 (♀, 74 yrs)	Aseptic loosening	Acetabular-only revision (third revision, right hip)	Dual mobility cup cemented into a trabecular metal revision shell with ilium buttress augment associated with a acetabular posterior column plating (AAOS stade IV acetabular bone defect with quadrilateral plate nonunion)	2 posteriors (276 days after rTHA)	- Developmental dysplasia of the hip - Proximal femoral varising osteotomy - Cemented Charnley-THA in 1973 - First both component rTHA for instability in 1984 - Periprosthetic acetabular fracture due to a traumatic fall in 2007 requiring unipolar acetabular revision with reconstruction using a dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect)	- Closed reduction under GA - Abduction bracing during 3 months	No 15 months FU
12 (♀, 71 yrs)	Aseptic loosening	Acetabular-only revision (fifth revision, right hip)	Dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect)	2 posteriors (22 and 33 days after rTHA)	- Developmental dysplasia of the hip - Proximal femoral varising osteotomy - Cemented Charnley-THA in 1976- First both component rTHA for aseptic loosening in 1983 - Second acetabular rTHA for instability with cup reorientation n 1990 - Two-stage rTHA procedure for chronic periprosthetic infection in 1997 - Fourth acetabular rTHA for instability in 2000 (all-PE liner with anti-dislocation crescent cemented in a Kerboull-cross plate)	- Closed reduction under GA - Abduction bracing during 3 months	No 46 months FU

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13 (♀, 84 yrs)	Aseptic loosening	Acetabular-only revision (third revision, right hip)	Dual mobility cup cemented in a Burch-Schneider cage (AAOS stade IV acetabular bone defect)	1 anterior (37 days after rTHA)	- Age >75 years - Cemented Charnley-THA in 1982 - First both component rTHA for aseptic loosening in 1991 - Second acetabular rTHA in 2005 for aseptic loosening using a dual mobility cup cemented in a Kerboull cross-plate (AAOS stade III acetabular bone defect)	- Open reduction - Abduction bracing during 3 months	No 51 months FU
14 (♀, 78 yrs)	Intra-prosthetic dislocation of a dual mobility cup 9 years after implantation (Fig. 4)	Acetabular-only revision (third revision, right hip)	Mobile bearing exchange of the dual mobility component (mobile PE component and femoral head) without cup removal	3 posteriors (41, 52 and 65 days after rTHA)	- Age >75 years - THA for right hip OA in 1995 - First acetabular rTHA for instability in 2002 - Second acetabular rTHA for instability in 2003 using a cementless dual mobility cup	Iterative acetabular rTHA using a constrained all-PE liner cemented into the well-fixed metal-back of the dual mobility cup	No 2 months FU
15 (♀, 76 yrs)	Aseptic loosening of an ipsilateral THA and TKA (Fig. 5A, B, C)	Acetabular revision and total femoral prosthetic arthroplasty (left hip, second revision)	Dual mobility cup cemented in a Kerboull cross-plate (AAOS stade III acetabular bone defect) associated with a total femoral prosthetic arthroplasty (bi-articular modular tumoral megaprosthesis) with greater trochanter reattachment onto the prosthetic proximal femoral metaphysis	2 posteriors (51 and 63 days after rTHA)	- Age >75 years - Severe erosive rheumatoid arthritis - Cemented Charnley-THA in 1989 - Cemented TKA in 1995 - Femoral and tibial revision TKA for femoral aseptic loosening in 1994 - ORIF of a left femoral supracondylar periprosthetic fracture in 2006 - Second femoral revision TKA for femoral nonunion in 2007 using hinged TKA implants with long cemented stem	- Iterative acetabular rTHA using a constrained all-PE liner cemented in the Kerboull cross-plate - Abduction bracing during 3 months	No 22 months

rTHA: revision total hip arthroplasty, THA: total hip arthroplasty, TKA: total knee arthroplasty, ORIF: open reduction and internal fixation, PE: polyethylene, OA: osteoarthritis, ASA: score of the American Society of Anesthesiologists, GA: general anesthesia, FU: follow-up, yrs: years.

[a] Associated with non-hinged knee bracing (Zimmer knee brace) with full weight-bearing during 3 weeks.

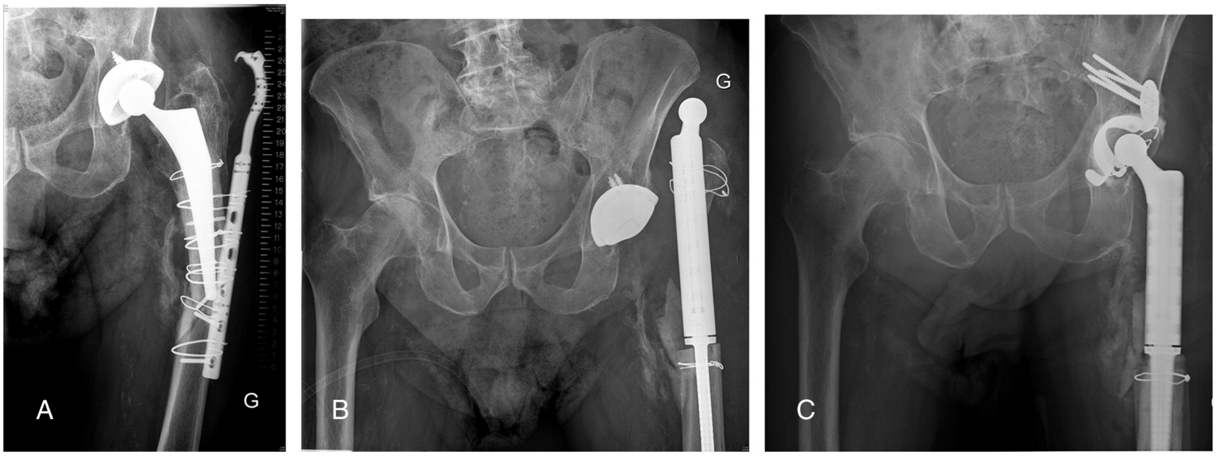

Fig. 3. Anteroposterior radiographs of the pelvis illustrating case #3. (A) Femoral nonunion of a Vancouver B1 femoral fracture associated with a major PE-related greater trochanter granuloma leading to rTHA. (B) Dislocation of a dual mobility cup cemented into a well fixed metal-back 29 days after acetabular and femoral revision performed without stable fixation of the remaining abductor mechanism onto the femoral metaphysis prosthesis. (C) Iterative acetabular revision using a constrained component cemented into a Kerboull cross-plate without recurrence of dislocation at 32 months post-operatively.

number of patients and/or analyzed various design and generation of implants [9–14]. In addition, concerns such as IPD due to accelerated PE wear have been raised in literature although these complications are likely to be less significant in older and lower-activity level patients such as most of the patients undergoing rTHA [2,15,25]. The current prospective study evaluated the outcome in terms of dislocation and IPD rates of a single design of dual mobility cup (Saturne®, Amplitude, Valence France) in a continuous series of 994 rTHA over a 12-year period. At a 7.3-year mean follow-up, the dislocation rate was 1.5%. Our results were in agreement with dislocation rates reported in previous series ranging from 0% to 8.7% at 2- to 8-year mean follow-up [2,9–14]. Five hips dislocated with identified technical error requiring iterative revision in 3 cases for dual mobility cup reorientation, isolated femoral revision with lengthening of a modular femoral metaphysis prosthesis and iterative acetabular revision using a constrained acetabular component (Table 1). Ten hips dislocated without perioperative technical error requiring iterative acetabular revision in 2 cases using a constrained acetabular component (Table 2). All the other cases of dislocation were managed by closed reduction followed by a period of bracing without recurrence at latest follow-up (Tables 1 and 2). In our practice, we advocate abduction bracing during 3 months particularly after iterative rTHA for recurrent dislocation associated with severe abductor mechanism deficiency [26]. Importantly, though literature reported significantly higher dislocation rates in acetabular-only revision when compared to both component revisions, we found no significant difference in dislocation rate between acetabular-only and both component revisions [27,28]. Therefore, this result emphasizes the ability of dual mobility cups to prevent instability even in the cases of acetabular-only revisions [12,20]. In addition, with an IPD rate of 0.2%, the current study confirmed previously reported rates of this specific complication ranging from 0.28% to 1% at 10 years follow-up [15–17]. The 2 cases of IPD occurred in acetabular-only revisions and were related to a poor head-to-neck ratio with early impingement and wear at the chamfer of the PE mobile component. Therefore, surgeon should be aware of this potential specific complication of dual mobility cups particularly in the context of acetabular-only revision. Despite the lack of scientific evidence, we strongly recommend caution when the retained femoral stem is not characterized by a smooth, polished and narrow femoral neck allowing satisfactory head-to-neck ratio in order to decrease subsequent wear of the PE liner's retentive chamfer [2,15–17].

As an alternative to stabilize the hip, large femoral heads have been demonstrated to significantly reduce the risk of dislocation in rTHA with similar rates than those reported with dual mobility cups [2,8–14,29]. In a recent RCT, Garbuz et al [8] reported dislocation rates of 1.1% and 8.7% with the use of 36/40-mm and 32-mm femoral heads, respectively. However, as the hip joint space is finite, the use of the largest-diameter head available could involve placement of a thin XLPE liner particularly when the acetabular reconstruction required cementation of a liner into a reinforcement device or a well-fixed metal-back [20,21]. Despite improvement in XLPE wear properties, large heads still produce significant wear with volumetric wear rates up to 157 mm^3/year with 36/40-mm heads versus 54 mm^3/year with dual mobility cups and 95 mm^3/year with constrained components in retrieval studies [5,25,30]. Therefore, due to the risk of early failure with liner fracture, a minimum XLPE thickness of 7 mm in the weight-bearing area and 4.8 mm at the rim was advised [30,31]. In addition, with dislocate rates up to 33%, large heads may be not effective in the presence of severe abductor mechanism deficiency [4,29,32]. Similarly,

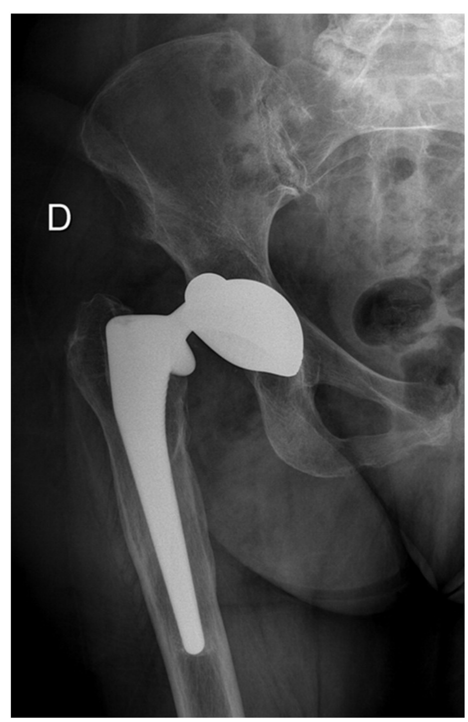

Fig. 4. Intra-prosthetic dislocation of the dual mobility cup illustrating case #9. The IPD is confirmed by the absence of radiographic shadow contrast of the PE mobile component around the femoral head.

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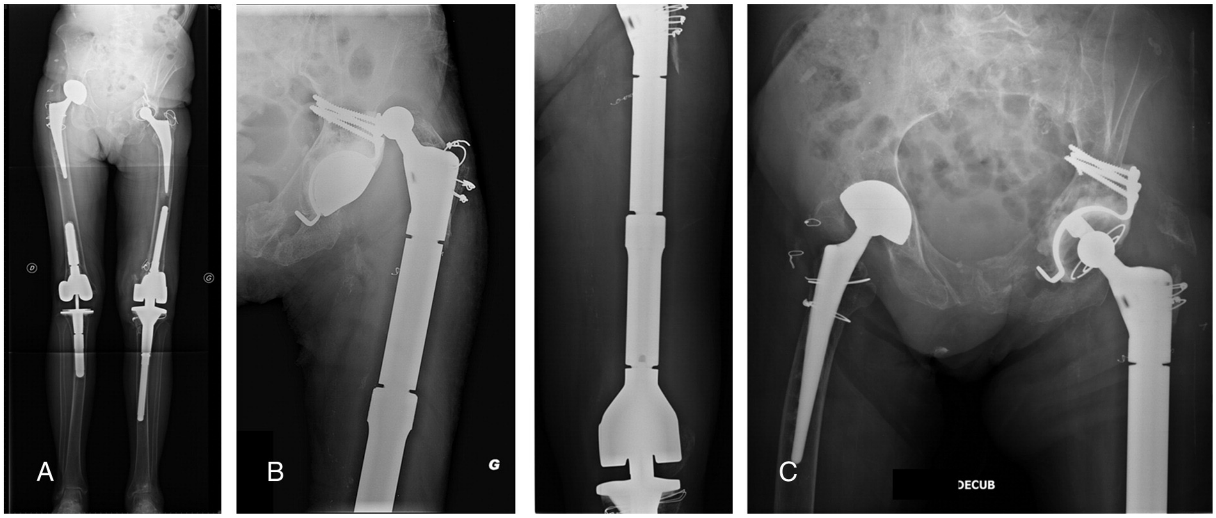

Fig. 5. Anteroposterior radiographs of the pelvis illustrating case #15. (A) Aseptic loosening of a left ipsilateral THA and TKA in a patient with severe erosive rheumatoid arthritis leading to rTHA. (B) Dislocation of a dual mobility cup cemented into a Kerboull cross-plate 63 days after acetabular and femoral revision using a total femoral arthroplasty with a bi-articular modular tumoral megaprosthesis and C/Iterative acetabular revision using a constrained component cemented into the Kerboull cross-plate without recurrence of dislocation at 22 months post-operatively.

9 of the 15 cases of dual mobility cup dislocation (60%) reported in the current study occurred in the context of severe abductor mechanism alteration related to technical errors or multiple hip surgeries (Tables 1 and 2). In contrast, with no association between abductor mechanism quality and the risk of recurrent dislocation, constrained liners have been suggested to efficiently compensate for the stability otherwise provided by the abductor mechanism [32]. Accordingly to the literature limiting the use of constrained liners to salvage situations of recurrent instability, we support their use in iterative rTHA associated with severe abductor mechanism alteration when previous attempts to stabilize the hip with a dual mobility cup have failed (Tables 1 and 2) [29,32,33].

Our study presented with some major limitations. Firstly, 17% of the patients were lost to follow-up or deceased at the time of the evaluation. Secondly, this TJR study was focused on dislocation and IPD rates after rTHA and did not evaluate the functional outcome, wear or survivorship of the dual mobility cup reconstruction at latest follow-up. Finally, no control group such as rTHA performed with constrained acetabular components or large femoral heads was available in this series since dual mobility cup represented our implant of choice in rTHA.

In conclusion, dual mobility cups demonstrated a low dislocation rate of 1.5% in rTHA. Importantly, our result emphasizes the ability of dual mobility cups to reduce the risk of instability even in the cases of acetabular-only revisions. However, dual mobility cups did not compensate for potential perioperative technical errors. Optimal orientation of the dual mobility cup and restoration of the abductor mechanism and leg length should be achieved during revision. In addition, with a rate of 0.2%, IPD did not appear to be a concern with respect to the benefit in term of instability prevention though caution is advised in unipolar acetabular revision associated with a poor head-to-neck ratio particularly when remaining stem did not present a smooth, polished and narrow femoral neck.

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