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ORIGINAL PAPER

Cementless dual-mobility cup in total hip arthroplasty revision

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Abstract
Purpose Dislocation is a frequent complication in total hip arthroplasty (THA) revision. Cup fixation is the second concern. In order to know outcomes at two years, we prospectively followed a continuous series of 78 patients to demonstrate that cementless dual-mobility cup (DMC) used in revision THA is safe as regards dislocation risk and bone fixation.
Method We enrolled 78 consecutive patients (79 cases) in a prospective study. Mean interval between index surgery and revision was 12.9 years. Mean age at revision was 75.5 years. Two types of cementless DMC were used: a standard DMC in 68 cases with low-grade bone defect (Paprosky grade 1 and 2), and a specific design reconstruction DMC in 11 cases with severe bone loss (Paprosky grade 3).
Results At two years of follow-up, 68 patients were reviewed; four were lost to follow-up., and six patients were deceased. We identified three types of situations at risk:standard risk (33 cases), Paprosky grade 1 or 2; medium risk (37 cases), revision for recurrent instability (21), periprosthetic fractures (14) or severe loosening Paprosky grade 3 without femorotomy (2); high risk (nine cases), revision for severe loosening with a femorotomy. One (1.3 %) patient dislocated her hip at one month without recurrence. Revision rate for dislocation was 0 %; two (2.7 %) early mechanical failures occurred.
Conclusion Considering outcomes of this series, cementless DMC can be suggested in THA revision surgery.

Keywords Revision total hip arthroplasty · Cementless dual-mobility cup · Dislocation · Cup fixation

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Introduction

Dislocation is the first complication in revision total hip arthroplasty (THA), with a rate ranging from 7.4 % to 25 % as reported in different series [1, 2]. Bozic et al. [3] compared the rate of dislocation in 12,000 revision cases versus 55,000 primary THA; dislocation rate was three times more frequent (14.4 % versus 3.9 %) in revision THA. A higher rate may be due to surgical, patient and implant factors [4]. When excluding septic loosening, midterm fixation of the revision cup is the second concern. Early fixation failure or aseptic loosening occurs more frequently in the first two years postsurgery, as reported in the New Zealand Joint Registry [5].

The dual-mobility cup (DMC) was introduced in France in 1976 by Gilles Bousquet and André Rambert. Several French authors have proposed using the DMC as a reliable option to prevent dislocation risk in revision surgery for any reason [6–9]. In 2012, Vasukutty et al. [10] also reported satisfying results when using DMC in revision TKA in the UK. DMC can be used cementless or cemented in combination with acetabular reinforcement [11]. The purpose of this study was to analyse outcomes of a continuous prospective series of

cementless DMC and evaluate whether this type of device used in revision surgery is safe regarding dislocation risk and bone fixation [12].

Materials and methods

From January 2010 to January 2012, we enrolled 79 hips (78 patients) in a prospective continuous cohort operated on by two senior surgeons at Clinique des Cèdres (Echirolles, France). Inclusion criteria were an exhaustive collection of grade 1 revision cases of primary THA for any reason, excluding all re-revision cases (grades ≥ 2). Patients were prospectively followed up at outpatient visits with a standard clinical and radiographic examination at three months and one and two years. If patients were not able to attend our office due to poor health conditions, we obtained general status, ability to walk and complication occurrence by phone. Patients unable to be contacted at that time were considered lost to follow-up. Cup revision for recurrent dislocation or migration is considered a failure. We also collected all medical complications that occurred during the study period. Radiographic analysis was done on an anteroposterior (AP) pelvic view and hip profile. Implant migration, radiolucent lines and osteolysis were analysed according to the method described by Martell et al. [13, 14].

All patients had a one-stage revision surgery. Both components were revised in 44 cases (55.7 %) and acetabular component only with or without head replacement in 35 (44.3 %). Two different types of DMC were used in this series. A standard cementless DMC (ADES®, Dedienne Santé, Mauguio, France) was used in 68 cases. The metallic shell is made of cobalt/chrome (Co/Cr) alloy. Bone fixation was achieved with a bilayer coating of Co/Cr spray (100 μm) with a hydroxyapatite (HA) coating of 80 μm (Figs. 1 and 2). Immediate fixation was obtained by press-fit effect. No fixation enhancement, such as screws, spikes or superior screw blades, were used. This standard component was used in Paprosky grades 1 and 2 [15]. Intraoperatively, we estimated that if we had a minimum of 40 % of close contact to the host bone, a standard cup could be used. Mean diameter of this cup was 54 (48–60) mm.

Fig. 1 Cementless standard dual-mobility cup ADES®, Dedienne-Serf

If severe bone loss was detected pre- or intra-operatively (Paprosky grade 3), we used a reconstruction cementless DMC (Integra cup®, Groupe Lépine, Genay, France). This cup is characterised by an intraosseous, 9.6-mm-diameter and 43.4-mm-long, HA-coated peg introduced through the acetabular roof in the iliac column [16], ensuring immediate stability and mid- and long-term bone fixation (Figs. 3 and 4). This specific reconstruction DMC was used in 11 cases. Mean cup diameter was 54 (50–58) mm and has no additional fixation devices, as reported by Sakai et al. [17].

Vargas and Caton [18] morcellised freeze-dried (TBF, Mions, France) allograft was used in 47 cases with the standard and in 11 cases with the reconstruction DMC. This allograft is not supercharged with mesenchymal stems, as reported by Hernigou et al. [19]. The femoral component was revised in 44 cases; all were cementless. The femoral implant was either a straight modular stem (18 cases) or a monobloc distally locked stem (26 cases) (Fig. 3). A regular posterolateral approach was used in all cases. A complementary femoral osteotomy according to Wagner was performed in 18 cases. All patients were allowed full weight bearing when walking, protected by two crutches, without restriction or external protection devices.

Bearing surfaces were metal on standard polyethylene (PE) in 75 cases (95 %) and alumina on standard PE in four patients < 55 years (5 %). In these four cases, modular sleeves [20] were not used to adapt the 28-mm head to the morse taper. Head diameter was 22.2 mm in 52 cases when the cup diameter was ≤ 54 mm, 28 mm in 27 cases when the cup diameter was ≥ 56 mm. Mean patient age at revision was 75.5 (45.1–93.8) years. Mean body mass index (BMI) was 25.1 kg/m^2 (17.1–34.3). Characteristics of this population at primary arthroplasty are presented in Table 1. At revision, patient characteristics are described in Table 2. The mean interval between primary arthroplasty and revision was 12.9 years (range three months to 29 years). The reasons for revision and mean interval between index surgery and revision are presented in Table 3.

At the two-year minimum follow-up, 61 patients had clinical and radiographic examinations. For seven patients, information was obtained by phone due to their poor health conditions. Four patients (four cups) were definitely lost to follow-up. Six patients had died from causes unrelated to hip surgery. All data were compiled in database File Maker Pro®.

Statistical analysis

Qualitative variables are presented as percentage and quantitative variables as mean or median, standard deviation (SD) and range.

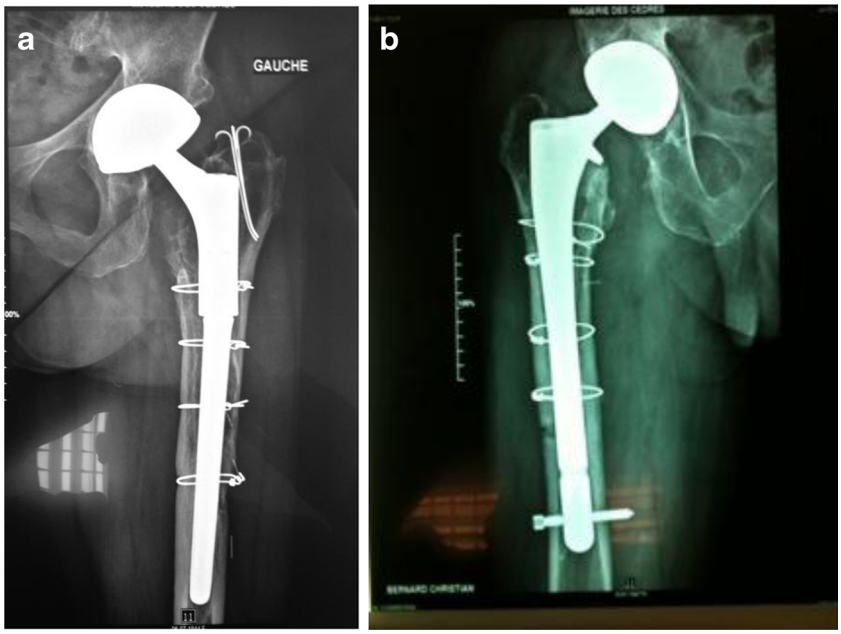

Fig. 2 **a** Bipolar revision: Conventional ADES dual-mobility cup associated with a cementless revision stem implanted through Wagner's femorotomy. X-ray at 1 year of follow-up. **b** Bipolar revision: Conventional ADES dual-mobility cup associated with a distally locked cementless revision stem. X-ray at 1 year of follow-up

Results

In this cohort we identified three types of risky situations regarding dislocation and fixation:

- Standard risk (group 1, 33 cases): patients with a low-grade bone defect Paprosky grade 1 or 2
- Medium risk (group 2, 37 cases): patients revised for recurrent instability (21) or periprosthetic fractures (14) or severe loosening Paprosky grade 3 without femorotomy (two cases)
- High risk (group 3, nine cases): patients revised for severe loosening Paprosky grade 3 with femorotomy

Dislocation rate was 1.3 % (1/79); revision rate for dislocation was 0 % for all groups. A 76-year-old patient (group 3) was revised for septic loosening 12 years after index surgery. Bipolar revision was performed with a femorotomy and acetabular reconstruction due to Paprosky grade 3 bone defect. She dislocated her hip one month postoperatively after a fall in her home; closed reduction was performed, and no recurrence was observed at three years.

Fixation failure rate at two years (removal of one or both component) was 2.7 % (2/79). Two early fixation failures occurred in group 2. One patient presented acetabular migration one month postoperatively. She was and 81-year-old ASA III at revision and was revised after 22 years for recurrent dislocation with severe wear of the acetabular component (cemented Charnley cup). A standard DMC was used. She fell in her home and dislocated the metallic shell of the DMC and the PE insert. Re-revision was performed. The second patient was a 51-year-old alcoholic patient with severe cognitive impairment. Revision was due to periprosthetic fracture (bipolar revision with a standard DMC). He fell three days after revision surgery and presented early traumatic expulsion of the metallic shell and PE insert. Acetabular cup was re-revised. Of

Fig. 3 Reconstruction dual-mobility cup INTEGRA®, Groupe Lépine

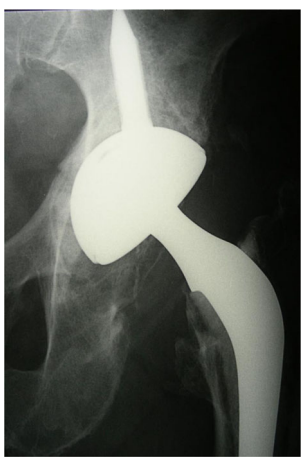

Fig. 4 Unipolar revision: INTEGRA® reconstruction dual-mobility cup. X-ray at 1 year of follow-up showing good integration of bone graft

Table 1 Characteristics of the population at primary arthroplasty ($n = 79$)

Characteristic	Number (%)
Male	24 (30.4)
Female	55 (69.6)
Mean age, years (min–max)	62.5 (33–92.1)
Cemented cup	16 (20.3)
Cementless cup	63 (79.7)
Cemented femoral implant	69 (87.3)
Cementless femoral implant	10 (12.7)
Metal-on-polyethylene bearing	62 (78.5)
Metal-on-metal bearing	7 (8.9)
Zirconium on polyethylene bearing	6 (7.6)
Alumina on polyethylene bearing	4 (5.1)
Head diameter 22.2 mm	52 (65.8)
Head diameter 28 mm	27 (34.2)

the 78 patients, 60 had a regular X-ray examination at two years. According to Martell et al. [13], we observed no cup subsidence, migration, significant radiolucent lines or cup loosening. We experienced one intra-operative fracture of the great trochanter, and postoperative complications within three months comprised two haematomas. Global infection rate at two years was 3.8 % (3/79). Two patients presented early infection. Immediate surgical lavage, synovectomy and antibiotic treatment were performed. In the first case, treatment was effective and the patient was considered cured. In the second case, treatment failed, and a bipolar revision was performed at six months; at two years, this patient was considered to be free of infection. One other patient presented a late infection at 14 months after surgery and was successfully treated. Mortality rate at two years was 7.7 % (6/78). One patient died within three months due to a visceral multifailure context. Five other patients died after three months (95, 91, 86, 82 and 80 years old): four were revised for periprosthetic fracture and one for infection. All these patients were American Society of Anaesthesiologists (ASA) grade 3. Medical complications were three heart failures, two renal failures and one pulmonary failure needing tracheotomy in a patient with cancer of the oropharynx.

Table 2 Characteristics of the population at revision arthroplasty ($n = 79$)

Characteristic	Number (%)
ASA	
1	7 (8.8)
2	30 (38.0)
3	42 (53.2)
Charnley	
A	25 (31.6)
B	42 (53.2)
C	12 (15.2)
Devane	
1	2 (2.5)
2	7 (8.8)
3	26 (33)
4	36 (45.5)
5	8 (10.2)

Table 3 Interval between primary total hip arthroplasty (THA) and revision

Characteristic	No. revisions	Interval (years)
Dislocation without wear	10	2.5
Dislocation with wear	11	14.6
Osteolysis with/without wear	20	18.8
Aseptic loosening	19	14.9
Periprosthetic fracture	14	10.3
Septic loosening	3	8.8
Technical error	1	0.3
Implant fracture	1	5.5

Discussion

The aim of this study was to analyse dislocation and fixation failure rates of cementless DMC used in revision THA. Multiple risk factors for dislocation must be considered in revision surgery, such as patient, implant and surgical factors.

Dislocation

In our series, dislocation rate was 1.3 % at two years whatever the cause of revision. We identified a higher-risk population (group 3). In this group, we experienced only one dislocation. Global dislocation rate was similar to to that published in our earlier publication [21] when using DMC in primary THA in high-risk patients.

In 2012, Vasukutty et al. [10] reported on 155 DMC in revision THA in the UK: Dislocation rate was 2.0 %, and none of the cases had further surgery at 42 months of follow-up. The authors conclude that DMC offers a satisfactory midterm outcome in patients undergoing revision THA. Philippot et al. [8] reported comparable results in THA revision surgery (3.7 % of dislocation in 163 revision THA using DMC at a mean follow-up of 60 months). Wegrzin et al. [11] reported on a prospective series of 61 revision THAs in American Academy of Orthopedic Surgeons (AAOS) grades III and IV acetabular defects using a Kerboull plate, structural allograft and cemented DMC. No dislocation at a mean follow-up of 7.5 years was reported. These series confirm good results with DMC in revision surgery regarding dislocation, and results are encouraging compared with those reported in which a standard cup is

used in revision arthroplasty; Wetters et al. [2] reported a dislocation rate of 9.8 % in 1,152 revision THA using standard cups.

The use of large femoral heads (≥ 36 mm) increasing the jump distance is reported to decrease dislocation risk [22]. Reports on the use of large femoral heads in revision surgery are rare. Skeels et al. [23] reported a dislocation rate of 17 % at a mean follow-up of 17.2 months when using a femoral head ≥ 36 mm. Amstutz et al. [22] observed a dislocation rate of 6 % at a mean follow-up of 5.5 years when using femoral heads ≥ 36 mm.

Bone fixation

Our results at two years of follow-up confirm that the cementless option may be reasonable, even in Paprosky grade 3 THA. Of 68 standard cementless DMC, two patients in group 2 presented with early mechanical cup failure. The first occurred on a high-risk patient without compliance and unable to comply with postoperative recommendations. The second was an early dislocation of the acetabular component after a fall in a patient revised for recurrent instability with severe cup wear 22 years after primary replacement. Excluding the two patients revised for septic loosening, at the term of the study, no patient required further surgery for acetabular cup loosening; no significant radiographic signs, radiolucent lines or loosening were observed. Among the 79 DMC, 11 were reconstruction cementless INTEGRA® DMC; we observed no mechanical failure.

Acetabular cup revision can be performed with or without cement. If severe bone defects were anticipated (Paprosky grade 3), in our series, a reconstruction cementless DMC was used. However, several other options are available in severe bone loss. Wegrzin et al. [11] reported a prospective series of 61 revision THAs in patients with AAOS grade III and IV acetabular defects using a Kerboull plate, structural allograft and cemented DMC. At a 7.5-year mean follow-up, 98 % of their patients presented no mechanical failures. Vasukutty et al. [10] compared 122 cementless versus 33 cemented DMC associated to bone graft and acetabular cage. At a mean follow-up of 42 months, three cases of loosening (two radiological and one re-revision) were observed in the cemented group; no revision occurred in the cementless group.

This series has some limitations, i.e. short-term follow-up and the small cohort size. Springer et al. [1] and information from the New Zealand national registry [5] demonstrate that in revision THA, dislocation and mechanical failures mostly occur within the first two years. Considering outcomes of this series, we propose that in THA revision surgery in which risk factors are high, cementless DMC may be a relevant option.

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