Dual mobility cup: dislocation rate and survivorship at ten years of follow-up

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Abstract

Purpose The dual mobility cup introduced in France by Gilles Bousquet has been used in total hip replacement in high-risk patients. This device acts as a large ball implant and significantly reduces the risk of dislocation following hip arthroplasty. Published French literature has focused on low rates of dislocation and long-term follow-up similar to the low-friction arthroplasty.

Methods We retrospectively reviewed a continuous series of 105 cases of dual mobility cup Quattro (Groupe Lépine, Genay, France) implanted from 2000 to 2002. Selection of the patients requiring a primary hip replacement depended on risk criteria such as age, hip disease and activity score. The dual mobility cup was associated with a modular cemented femoral component and a 22.2-mm stainless steel head.

Results One dislocation occurred one month after the index surgery requiring no revision surgery. According to the Kaplan-Meier method, survival probability was 95.0 % (95 % confidence interval 81.5–98.8) at ten years of follow-up.

Conclusions Based on clinical outcome and patient assessment we conclude that the dual mobility cup is a reliable option to decrease dislocation risk without increasing polyethylene wear.

Keywords Hip arthroplasty · Dual mobility cup · Dislocation · Survivorship · Polyethylene wear

Introduction

As published by Bozic et al. [1] and according to national registries of Sweden, Australia, England and Wales [2–4], dislocation became the prime reason for revision in the first year after hip arthroplasty. Different factors [5] may influence joint stability such as patient factors, surgical factors and prosthetic factors. The main patient risk factors are gender, age and aetiology [2, 6–10]. Surgical risk factors are posterolateral approach [2, 9, 11] and implant malpositioning [7]. The major prosthetic risk factor is the 22.2-mm femoral head diameter [2, 12].

For 15 years many reports [6, 13, 14] concluded that dislocation risk is decreased with the dual mobility cup (so-called tripolar unconstrained modular cup) first introduced in France by Gilles Bousquet in the mid-1970s. The major concern about this type of implant was polyethylene wear at long-term follow-up. Recently, Vielpeau et al. published long-term outcomes of the dual mobility cup and concluded that polyethylene wear was comparable to standard expectations [14].

The purpose of this study is to demonstrate that in a population at risk for dislocation requiring hip replacement a dual mobility cup (Quattro®, Groupe Lépine) associated with a cemented Charnley-type femoral component could be considered as a trustworthy and reliable surgical option with regard to the risk of dislocation and survival probability of the cup.

Material and method

A total of 105 primary total hip arthroplasties (THAs) in 102 patients using a dual mobility cup were retrospectively reviewed in 2012. The THAs were performed between April 2000 and September 2002 at the Clinique des Cèdres (Echirolles, France) by the senior author (JL Prudhon). These

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THAs represent a consecutive series of dual mobility cup. During this period, 692 THAs were performed by the same senior author at the same institution. All of our THAs have been recorded in a computer database (FileMaker®) since 1990.

Patient selection depended on risk factors such as age, comorbidities, American Society of Anaesthesiologists (ASA) classification and aetiologies (i.e. fracture, avascular osteonecrosis). Each patient was affected by at least one risk factor.

In 2012, an attempt was made to reach all of the patients by mail or phone call. If the patient was reached and agreed to an outpatient visit, an appointment was set up; otherwise data were collected by mail or phone call. If the patient was not reachable, data of the last outpatient visit were used. Patients operated upon between April 2000 and September 2002 who never returned to any routine visits were considered as lost to follow-up.

Preoperative data consisted of age at index surgery, gender, ASA score, Charnley grade, Postel Merle d'Aubigné (PMA) [15] and Devane [16] activity scores, side affected, specifications of the implants and surgical approach.

Post-operative data comprised the occurrence of complications (requiring or not requiring revision surgery), satisfaction score, Devane activity score, complications, vital status, PMA score and radiological evaluation at the longest follow-up (pelvis in frontal plane and hip in a sagittal plane, criteria: migration of the femoral head according to the centre of the metal back, lucent lines, osteolysis).

The dual mobility cup (Quattro®, Fig. 1) used in this series was composed of a cementless stainless steel metal back whose primary fixation is achieved by four apical spikes associated with eight equatorial fins. Secondary fixation is obtained by a coating made of hydroxyapatite deposited by plasma spray.

The inner surface of the cup is highly polished without any holes for screws or spikes or additional fixation devices (hooks, flanges). The liner is machined from standard ultra-high molecular weight polyethylene (UHMWPE) sterilised by ethylene oxide. A specific design of the liner was made to decrease contact between the retention rim and the neck of the femoral component (Fig. 2).

The dual mobility acetabular component was associated with modular Charnley-type cemented femoral stems (Groupe Lépine). Orthopaedic bone cement with antibiotics (AMINOFIX 3®, Groupe Lépine) was used in all of the cases (second-generation cementing technique) and a cement restrictor AIR PLUG® (Groupe Lépine). All of these implants had a ten millimetre diameter neck, associated with a 22.2-mm stainless steel head.

Preoperative planning was carried out routinely. Surgery was performed through a posterolateral approach in a supine lateral position. The acetabulum was prepared using spherical

reamers. Osteophytes were removed and reaming was stopped when satisfactory bleeding of the inner bone of the acetabulum was obtained. Trial implantation made it possible to check the fit and close contact to the bone. To facilitate the cup positioning, an over-reaming of two millimetres was done. The cup was inserted at an ideal angulation of 45° in the frontal plane and a range of 0–20° of anteversion. Attention was paid to the anterior overhang of the cup. The easiest way to check was to palpate the anterior position of the cup and the gap between bone and metallic shell. The capsule was repaired after reduction. Full weight-bearing was allowed immediately after surgery. Patients were discharged after a mean hospital stay of six days.

Qualitative variables were presented as percentage and quantitative variables as mean or median, standard deviation and range. Survival probability, considering revision surgery of the cup for any reason as endpoint, was computed according to the Kaplan-Meier method with Stata software. Comparisons of quantitative variables were performed by Student's *t* test (*p* less or equal to 0.05 was considered as significant).

Results

Preoperative

Of the included patients 61 were women (59.8 %). The mean age at the index surgery was 78.0 years ($\pm$ 5.3, range 39.8–93.5 years). There were 59 right hips (56.2 %). The Devane and ASA scores and the Charnley classification are presented in Table 1. Of the patients, 55.1 % were Devane 4, i.e. semisedentary or household chores, 90.1 % were ASA 2 or 3 and 45.1 % were Charnley B or C. Aetiologies are reported in Table 2. Of the THAs, 9.4 % were implanted due to hip fracture or osteonecrosis.

In two hips a previous operation had been done (open reduction internal fixation of femoral neck fracture). The mean preoperative PMA score was 5.9 of 18 points ($\pm$ 0.8, range 3–10).

Post-operative

Twenty-four patients (23.5 %) died since the index surgery of unrelated causes. Data came from the outpatient visit in 40.2 % (only six patients agreed to come for an outpatient visit in 2012), mail in 2.0 % or phone call in 25.5 % of the cases. Nine patients were lost to follow-up (8.8 %).

At a median follow-up of 91 months, one THA patient (0.9 %) experienced an episode of dislocation one month after the index surgery. This dislocation was successfully managed by closed reduction (no revision surgery was required). No recurrence was further observed.

Fig. 1 The Quattro® dual mobility cup associated with a Charnley-type femoral stem

Survival probability was 95.0 % (95 % confidence interval 81.5–98.8) at ten years of follow-up (Fig. 3). Two acetabular component revision operations were required related to loosening. The first case occurred in a 76.2-year-old man operated upon for arthritis, weight 75 kg, height 170 cm, Charnley grade A, ASA score 2, developed aseptic loosening at 101 months of follow-up. Aseptic loosening was secondary to a non-union of periprosthetic Vancouver type B fracture previously managed by orthopaedic treatment.

Fig. 2 Specific design of the liner

Table 1 Devane and ASA scores and Charnley classification

Parameter	n (%)
Devane score	
1 (strenuous labour/contact sports)	0
2 (light labour/non-contact sports)	3 (3.1)
3 (leisure activities/gardening)	40 (40.8)
4 (semisedentary/household chores)	54 (55.1)
5 (sedentary/dependent)	1 (1.0)
ASA score	
1	10 (9.9)
2	74 (73.3)
3	17 (16.8)
4	0
5	0
Charnley classification	
A	57 (54.8)
B	43 (41.3)
C	4 (3.8)

The acetabular shell was not revised but a new UHMWPE liner was inserted. The second case affected another man aged 55.8 years at the index surgery, weight 85 kg, height 175 cm (overweight), Charnley class B, ASA score 2, revised for bipolar septic loosening at 108 months of follow-up.

Besides dislocation and complications requiring revision of the cup, five post-operative complications were observed: two cases of early venous thrombosis, one case of early urinary tract infection and one case of early haematoma. Lastly, one case of periprosthetic femoral fracture occurred at 117 months of follow-up requiring revision surgery for femoral stem removal and exchange. The acetabular component was not affected.

At the median follow-up, 97 % of patients were very satisfied or satisfied. The Devane activity score was 3 in 12.8 % of patients, 4 in 83 % of patients and 5 in 4.2 % of patients, corresponding to a decrease in the activity level. The PMA score was significantly improved at the last follow-up (mean post-operative PMA score of 17.5 points versus mean preoperative PMA score of 5.9 points, $p < 0.05$). Radiological

Table 2 Aetiology

Parameter	n (%)
Aetiology	
Arthritis	94 (90.6)
Osteonecrosis	6 (5.6)
Fracture	4 (3.8)

Fig. 3 Survival probability of dual mobility cup

evaluation at the last follow-up did not reveal any cup migration, loosening or osteolysis (Fig. 4).

Discussion

The results of this retrospective non-randomised series demonstrate that dislocation risk is low (0.9 %) and the wear process may be compared to low-friction arthroplasty [17, 18]; survival probability was 95.0 % at 120 months of follow-up.

Dislocation

Dislocation after THA is an important complication. According to the Swedish Hip Arthroplasty Register [2], dislocation is the prime reason for revision in the first year after surgery. Today in the USA, the most common cause of revision (22.5 %) is instability with dislocation of the hip [1].

Fig. 4 Dual mobility cup at 10 years of follow-up

Factors influencing joint stability [5] are patient factors, surgical factors and prosthetic factors.

As regards patient factors, several studies have clearly described dislocation risk factors after primary total hip replacement: gender, age, ASA score, aetiology and comorbidities [2, 6–10]. Women have a higher dislocation risk compared to men. In the described population 59.8 % were women. The cumulative risk increases when age is over 70 years. In this series the mean age at surgery was 78 years (range 36–90) and 89.5 % were over 70 years. As described by Jolles et al. [7], ASA score over 2 is also a risk factor. In this series, 90.1 % of patients were ASA 2 or 3. Dislocation risk is also increased in several aetiological conditions such as fracture, osteonecrosis of the femoral head, dysplasia and rheumatoid arthritis. Lee et al. [19] reported 10 % of dislocation in a series of THAs in femoral fractures at the Mayo Clinic. In this series 5.6 % of the patients had osteonecrosis of the femoral head and 3.8 % had a neck fracture.

As regards surgical factors, the posterolateral approach increases dislocation risk [2, 9, 11]. We routinely used a posterolateral approach in this series with a capsule repair or a partial trochanteric osteotomy preserving all of the posterior capsule and muscles in five cases.

Concerning prosthetic factors, the use of a 22.2- or 28-mm femoral head seems to increase dislocation risk [2, 12]. In this whole series, femoral head diameter was 22.2 mm. In this series we experienced only one early dislocation reduced by conservative treatment without recurrence.

Large femoral head diameters may be an alternative to prevent dislocation, as published by Stroh et al. [20]. The concept of a dual mobility cup may be compared to that of large femoral head diameters. For instance, the smallest size of UHMWPE liner has an outer diameter of 38 mm, acting as a large femoral head (Fig. 2).

Thus, in this series of patients at risk of dislocation using a dual mobility cup, the dislocation rate at a median follow-up of 91 months is low (0.9 %) compared to the dislocation rate in primary hip replacement using a conventional cup. Indeed, Ali Khan et al. [21] in a retrospective study on 6,774 conventional cups reported 2.1 % of dislocation. In the same way, García-Cimbrelo and Munuera [22] published a dislocation

rate of 2.97 % (61 dislocations in 2,050 conventional cups). These results are confirmed by Adam et al. [23] who reported on a prospective multicentre cohort of 214 neck fractures treated with a dual mobility cup. Only three patients (1.4 %) dislocated their hip at the longest follow-up. Also, Guyen et al. [6] reported no dislocation at 40.2 months of follow-up in 167 primary THAs in patients at high risk for instability. Lastly, another series [13] of the dual mobility cup used in primary THA has been published with the same results regarding dislocation rate (one dislocation in 53 patients, 1.8 %, at 78.9 months of follow-up).

Wear process is not increased in dual mobility cups

The wear process is responsible for osteolysis and/or component loosening. Polyethylene wear may be difficult to detect on X-rays due to the socket; if significant polyethylene wear is a possible complication of a dual mobility cup, an increased ratio of osteolysis in this type of cup would be noticed. None of our patients have been revised for osteolysis. Two patients were revised for loosening. Neither loosening was due to polyethylene wear but secondary to a triggering factor: one trauma (periprosthetic fracture) and one late infection. Implant survival is excellent with a 95 % survival probability at ten years of follow-up with revision of the cup for any reason as endpoint compared to results observed in registries [2, 4]. This series outcome may indirectly prove that there are no major polyethylene wear concerns at ten years of follow-up.

Among the published papers the risk for revision of dual mobility cups due to osteolysis is no higher than in a conventional cup [14]. Wear can be considered as similar to a traditional 22.2-mm metal-on-polyethylene bearing surface [24]. Another indirect sign of the wear process is the so-called intraprosthetic dislocation. Contact between the neck of the stem and the retaining device of the polyethylene liner may produce wear and debris. The weakness of the retaining device can be responsible for late dislocation between the femoral head and the polyethylene liner. These intraprosthetic dislocations have been described by Lecuire et al. [25]. In our series at the longest follow-up we have not encountered such a complication.

Even though this study is retrospective and non-randomised, we can assess that the dual mobility cup may be considered as an interesting surgical option in a population at risk for dislocation requiring primary hip replacement. These results are comparable with other long-term French series of dual mobility cups. On the other hand if we consider the facts that the mean age of the patient needing primary hip replacement according to the Swedish Hip Arthroplasty Register [2] is 67 years for men and 69 years for women, and that 45 % are over 70 years at index surgery, a dual mobility cup could be a reasonable surgical option in this particular population.

Conflict of interest Jean-Louis Prudhon and André Ferreira are consultants of Groupe Lépine. Régis Verdier is employed by Groupe Lépine as an epidemiologist.

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