The use of cemented dual mobility acetabular cup in revision hip arthroplasty

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Purpose
Instability is always an important problem after both primary and revision total hip arthroplasty (rTHA). Dual mobility or tripolar unconstrained acetabular components give a solution for preventing and treating instability. Results of many studies using dual mobility cups (DMC) with mid-term to long-term follow-up support their effectiveness. Complications such as intraprosthetic dislocation (IPD) and accelerated wear have been studied, although they seem to be less significant in older, low-demand patients. However, their use in younger patients should be with caution owing to the lack of current data concerning this high-demand patient population.
The aim of this study is to analyze the short-term results of cemented DMCs in rTHA. Specifically, we evaluated the following: clinical outcomes and scoring, dislocation, IPD rates, and other complications.
Patients and methods
The results of a single design of DMC was prospectively evaluated in a continuous series of 20 rTHAs. Follow-up period was of at least 2 years. Mean age of the patients was 66.8 years old.
Results
At the 2-year mean follow-up, the dislocation rate was 5%, and the IPD rate was 0%. Improvement of the hip score, function, pain, and range of motion was noticed.
Conclusion
DMCs demonstrated a low dislocation rate in rTHA but did not solve problems related to perioperative technical errors. Moreover, IPD did not appear to be a concern when compared with the gain of preventing instability.

Keywords:
dislocation, dual mobility, revision hip arthroplasty, tripolar

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Introduction

Total hip arthroplasty (THA) is considered one of the most successful surgical procedures providing pain relief and improvement of quality of life in patients with advanced hip arthritis that is not improving with nonoperative treatments [1,2]. As health services continue to improve and life expectancy increases, the need for total joint replacement will increase to cope with the basic needs of this growing portion of the population [2,3].

Dislocation and repeated instability continue to be the most common indication for both revision and re-revision THA, with dislocation rates after primary THA range from 0.3 to 9% [4–6], whereas after revision total hip arthroplasty (rTHA) reportedly range from 5.1 to 27% of cases. Repeated hospital admission and revision surgeries increase economic cost as the surgical treatment of a dislocating THA can raise cost by 148% [1].

Over the past few years, large femoral heads, constrained prosthesis, and dual mobility acetabular cups have been introduced to solve this challenge with varying success [7,8]. Although constrained acetabular cups showed high rates of mechanical loosening, dislocations, and limited of range-of-motion, large femoral heads showed also problems related to accelerated wear and increased incidence of local tissue reactions [9].

Recently, dual mobility (DM) prostheses were introduced with design concepts that address instability and avoid the problems of large femoral heads and constrained cups [10] In a DM system, a small-diameter femoral head articulates with a polyethylene liner and together form a large femoral head construct which in turn articulates, while still mobile within an inner acetabular shell [11]. Therefore, this design gives greater impingement-free range of motion and a larger head-to-neck ratio, resulting in

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increased jump distance, reducing the risk of intraprosthetic dislocation (IPD) [3,12–15].

This study reviews the use of these cups in rTHA, particularly where stability is in doubt. Dual mobility cups (DMC) may be used in risky primary total hip replacement, such as elderly patients with increased comorbidities and those with a neuromuscular diseases. They are used at revision surgery where the risk of dislocation is high, such as in patients with many prior dislocations, patients with aseptic loosening, or those with abductor deficiency [16].

The current series prospectively evaluated the outcome of a single-design DMC in rTHA with respect to clinical outcomes and scoring, dislocation, and IPD rates at short-term follow-up [4].

Patients and methods

Between November 2013 and November 2016, 20 DMCs were implanted during cup exchange in revision hip arthroplasty in 20 patients and were prospectively included in our study and a follow-up of at least 2 years was done. Informed consent (approved by the Research Ethics Committee in Ain Shams University, Faculty of Medicine) was obtained from all individual participants included in the study. The reasons for choosing a DMC were older age and risk factors for hip instability (i.e. multiple revisions or revision for hip instability or old infection). The indications for cup exchange were for recurrent dislocation (n=3), aseptic loosening (n=16), and infection (n=1) with two-stage surgery done (Tables 1, 2).

Exclusion criteria were primary THA procedure, revision performed in case of bone tumors, young age group, and femoral-only revision.

Table 1 Indications for surgery for the patients included in the study

Indication	Acetabular-only revision	Both components revision
Infection	–	1
Aseptic loosening	13	3
Recurrent dislocation	3	–

Table 2 Number of patients requiring graft for reconstruction of acetabular defect

Sex	Use of minimal acetabular graft	Use of bulk structural graft	No graft needed
Male	1 case	1 case	10 cases
Female	–	2 cases	6 cases

The eight females and 12 males had a mean age of 66.8 years (range, 55–80 years) at revision surgery.

The clinical data, Harris hip score [17], and radiological findings were assessed and recorded preoperatively, immediately postoperatively, 6 weeks, 6 months, 1 year, and 2 years postoperatively. The radiographic evaluation was done with an anteroposterior view of the pelvis and anteroposterior and lateral views of the operated hip (Fig. 1). Osteolysis and radiolucent lines in the acetabulum were evaluated on serial radiographs in the DeLee and Charnley zones. Loosening was defined as more than 3° of change in the cup inclination angle or more than 3 mm of cup migration [18].

All revisions were performed through the modified Hardinge approach by two senior surgeons. All patients were positioned in the dead lateral decubitus position. The preservation of the glutei, their nerve supply, and muscular attachment to the femur was done. We suspended the gluteus medius and gluteus minimus on stay sutures and re-sutured them again at the end of operation rather than detaching them from the bone. This preserves the gluteus minimus and avoids injury to the superior gluteal nerve.

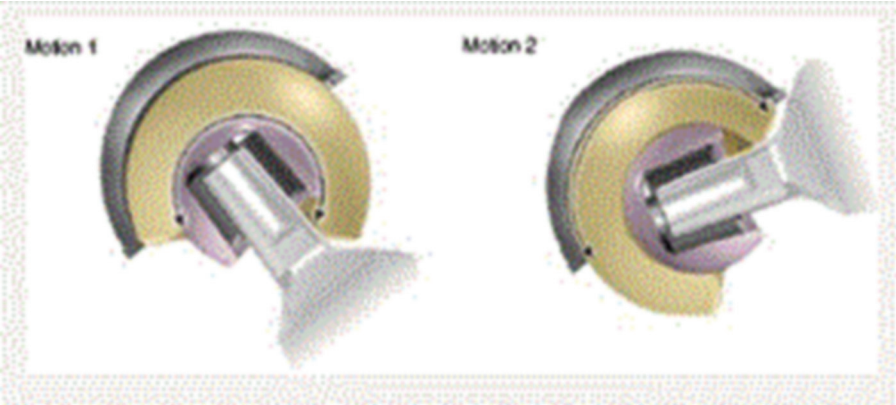
After acetabular component removal and granulomatous tissue debridement, acetabular bone deficiency was addressed and graded according to the 4-grade classification of the AAOS [19].

After 4 min of manual mixing at controlled-operating room temperature (19–22°C) and humidity (43–53%), a doughy texture of the cement was obtained. Then, the cement was thickly applied into the shell. The DM (Avantage; Biomet, Warsaw, Indiana, USA) 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 DMC [20] (Fig. 2).

After application of the femoral stem, assembly of metal head into mobile polyethylene liner was done (Fig. 3) and introduced over the stem (Fig. 4), and then reduction of the prosthesis was done.

Postoperative 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 postoperatively and full weight bearing thereafter.

Figure 1



Two-stage revision surgery with the use of cemented dual mobility acetabualar cup. (a) Preoperative radiography with acetabular and femoral septic loosening, (b) removal of the prosthesis and application of a spacer, and (c) application of cemented dual mobility cup after infection subsided.

Figure 2

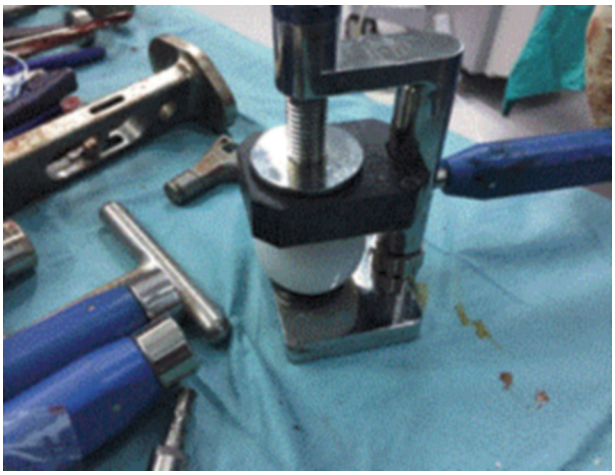
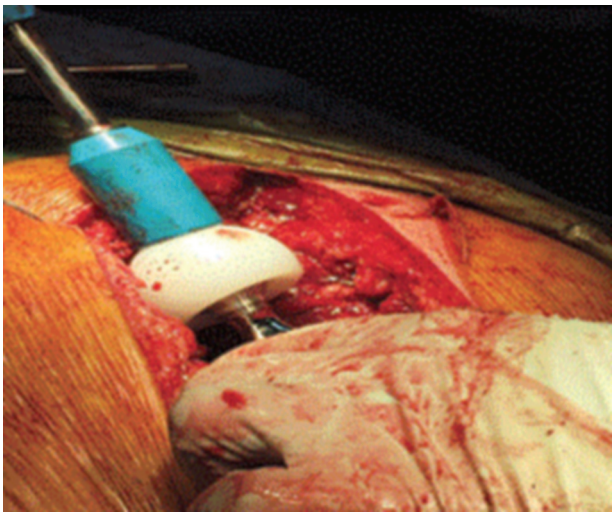


Diagram explaining motions occurring in the dual mobility cup. The first motion occurring between the head and the polyethylene liner, and then the second motion between the polyethylene liner and the cemented cup [6].

Figure 3



Assembly of the metal head into the mobile polyethylene liner.

Results

Follow-up in these 20 cases was at least 24 months.

Of the 20 assessable cases, one underwent debridement for repeated wound infection, and one case had dislocation of the joint between the cemented cup and the outer polyethylene, requiring reduction by external maneuvers under general anesthesia 11 months after cup exchange for hip instability. No patients experienced IPD.

Mean cup inclination in the coronal plane was 44.9° (38°–54°). A continuous 2-mm radiolucent line was visible in one asymptomatic patients. The line remained stable over time and was associated with osteolysis in zones 1.

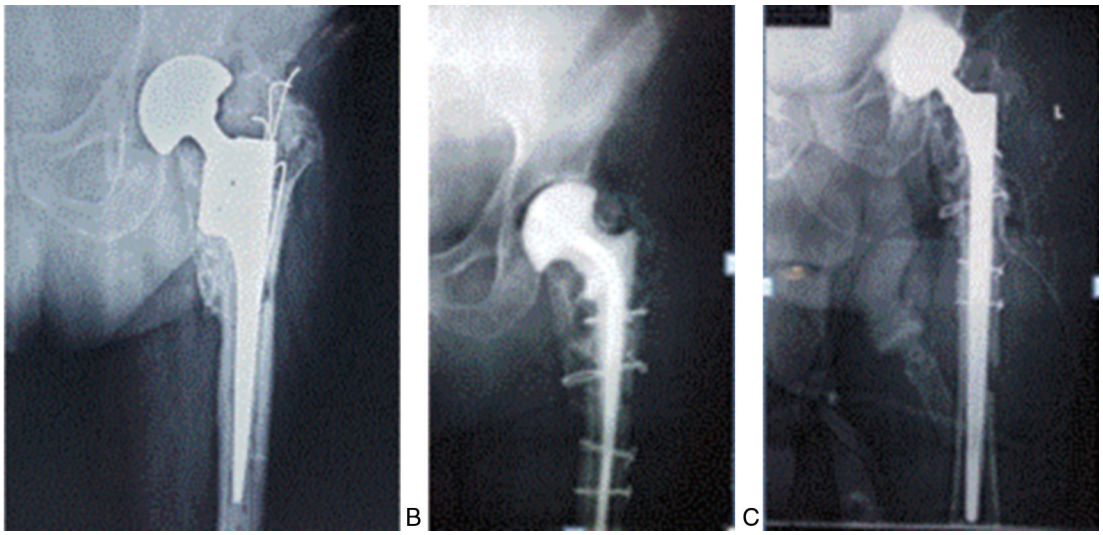
There was no significant difference between acetabular-only revisions and both component revisions respectively (P=0.8). No recurrence of the dislocation was reported after appropriate management.

The final Harris hip scoring was much better with significant improvement of the overall scoring after the total period of follow-up with better quality of life (Table 3).

Discussion

The outcome was satisfactory, with a single case of late dislocation, and is comparable to previously reported rates of DMC survival in rTHA [2,18], but comparisons between studies are difficult because patients and indications vary greatly from one study to another.

Figure 4



Head polyethylene liner introduced over the stem.

Table 3 Comparison of Harris hip scoring between preoperative, 6 weeks, 6 months, 1 year, and 2 years postoperatively

	Preoperatively	6 weeks postoperatively	6 months postoperatively	1 year postoperatively	2 years postoperatively
Harris hip score					
Range	19–52	58–83	72–97	75–99	74–98
Median (IQR) [*n* (%)]					
Harris hip score	40 (23–44)	75 (67–81)	83 (76–86)	86 (80–97)	86 (79–96)
Poor (<70)	20 (100)	6 (30)	0	0	0
Fair (70–79)	0	6 (30)	6 (30)	4 (20)	4 (20)
Good (80–89)	0	8 (40)	12 (60)	10 (50)	10 (50)
Excellent (90–100)	0	0	2 (10)	6 (30)	6 (30)

While discussing our results, we have to keep in mind some points. Our goal was to assess DMC dislocation rates after revision surgery for any reason. Second, the mean follow-up period is 2-year follow-up, which may seem insufficient; however, it should be kept in mind that a substantial proportion of complications develop within the first 3 years.

Instability is among the main complications of prosthetic revision surgery. The dislocation rate in our study was one case which is comparable to the rates found in other studies of DMC use for rTHA [21,22]. Garbuz *et al*. [23] reported benefits from using large-diameter heads (36 and 40 mm) to prevent instability in exchange THA, but they have the major drawback of inducing marked polyethylene wear. The risk of wear is lower with DMCs, as reported by Adam *et al*. [24].

Several studies demonstrated lower loosening rates with DMCs than with constrained cups [18]. The low dislocation rate supports our policy of using DMCs almost routinely for rTHA. However, the dislocation rate was higher than for primary THA [25], in which the dislocation rates after DMC implantation are less than 1%.

Numerous factors influence the stability of a THA, including implant positioning, the number of previous surgical procedures, and the presence of muscle damage related to extensive dissection. These risk factors for dislocation are more common in patients undergoing revision compared with primary THA.

Cemented metal cups are associated with high rates of loosening and polyethylene wear. In our study, one hip with a DMC cemented onto the bone was surrounded by a radiolucent line, indicating a need for close monitoring. Other studies found no cases of loosening of DMCs cemented onto bone [18], a fact that may reflect decreased stresses at the cement-bone interface.

The jumping distance represents the prosthetic stability of any hip arthroplasty, with inverse relation

between the risk of dislocation and this distance. The jumping distance of a dual mobility construct is greater than that of any acetabular cup design. That is why, the dual mobility design is theoretically the most stable device. However, important rules must always be followed during implantation and orientation of a DMC [4].

DMCs have gained worldwide attention as an option in the prevention and treatment of instability particularly in rTHA. Indeed, several European studies reported that DMCs could offer the benefit of increased stability without compromising clinical outcomes and implant fixation durability [22].

Concerns such as IPD due to accelerated polyethylene 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 [26].

In our study, we did not experience IPD, which was almost similar to previously reported rates of this specific complication, ranging from 0.28 to 1% at 10-year follow-up.

Conclusion

Instability remains a significant issue after both primary and rTHA. DM or tripolar unconstrained acetabular components can provide a viable alternative in preventing and treating instability.

Our findings indicate that use of a cemented DMC reduces the short-term to mid-term risk of a second revision in first-time revisions compared with classic cup designs with low dislocation and complication rates. Longer follow-up is needed to establish any long-term clinical advantages when DMCs are used in revisions performed owing to dislocation [2,3,13].

In conclusion, DMCs demonstrated a low dislocation rate in rTHA. Importantly, our result emphasizes the ability of DMCs to reduce the risk of instability even in the cases of acetabular-only revisions. However, DMCs did not compensate for potential perioperative technical errors; optimal orientation of the DMC and restoration of the abductor mechanism and leg length should be achieved during revision. In addition, IPD did not appear to be a concern with respect to the benefit in term of instability prevention [4].

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Conflicts of interest
There are no conflicts of interest.

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