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A double mobility acetabular implant for primary hip arthroplasty in patients at high risk of dislocation

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ABSTRACT

INTRODUCTION Dislocation following total hip replacement continues to be a problem for which no completely satisfactory solution has been found. Several methods have been proposed to reduce the incidence of hip dislocations with varying degrees of success, including elevated rim liners, constrained liners and large diameter bearings. We present our experience with the double mobility acetabular component in patients at high risk of instability.

METHODS This was a retrospective review of 65 primary total hip arthroplasties in 55 patients (15 men, 40 women), performed between October 2005 and November 2009. The majority (80%) of patients had at least two and 26% had at least three risk factors for instability. The mean age was 76 years (range: 44–92 years). The patients were followed up for a mean duration of 60 months (range: 36–85 months).

RESULTS Fourteen patients died and one was lost to follow-up, leaving fifty hips for final assessment. Until the final follow-up appointment, no patients had dislocation and none required revision surgery. The mean Oxford hip score improved from 45.0 to 26.5 ($p<0.0001$). The mean Merle d'Aubigné pain score improved from 1.4 to 4.9 ($p<0.0001$), the walking score from 2.3 to 3.1 ($p<0.07$) and the absolute hip function score from 5.4 to 10.8 ($p<0.0001$). There were no clinical or radiographic signs of loosening.

CONCLUSIONS The double mobility acetabular component was successful at preventing dislocation during early to medium-term follow-up. However, as data are still lacking with regard to polyethylene wear rates at the additional bearing surface, it would be prudent to restrict the use of this implant to selected patients at high risk of instability.

KEYWORDS

Double mobility – Dual mobility – Tripolar cup – Hip instability

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Hip dislocation is a troublesome complication after total hip arthroplasty (THA), and a leading cause for revision after aseptic loosening and pain.[1] Although varying from 1% to 9% depending on published reports, the incidence rate can perhaps be taken as 1–5%.[2–5] The rate was found to be higher in certain groups of patients. Patients with previous hip surgery and failed fracture fixation have a higher rate of dislocation.[2,5–10] In their review of 10,500 THAs, Woo and Morrey found that the incidence doubled from 2.4% to 4.8% for patients who have had previous hip surgery.[2]

Cognitive dysfunction appears to be another factor associated with a higher dislocation rate.[11–13] In a randomised controlled trial of 100 patients aged 75 years and older, Johansson *et al* found that the dislocation rate rises to 32% in patients with mental dysfunction.[13] Female sex has also been reported to be associated with dislocation. In large cohort studies of 10,500 and 6,623 THAs respectively, Woo and Morrey and Berry *et al* showed that the incidence of dislocation is 2–3 times higher in women than in men.[2,4] Yet another factor reported to contribute to dislocation is advanced age.[4,7] Also reported are inflammatory arthritis, avascular necrosis, neurological disorders such as Parkinson's disease and cerebral palsy, and an ASA (American Society of Anesthesiologists) grade of ≥3.[4,6,8,10,11,14,15]

With the above mentioned factors documented to predispose to hip instability in isolation, one should expect a higher risk when several of them coexist in the same patient. An example would be a female patient over the age of 80 years with previous hip surgery from a femoral neck fracture. The challenge in preventing dislocation on that particular patient may therefore be greater. If a technique to resolve this issue were found to be advantageous with respect to the pantheon of options available, it should be regarded as a welcome option for further investigation.

We present our experience with 65 THAs in 55 patients who presented with one or more risk factors for dislocation using a double mobility (DM) cup (Saturne®; Amplitude, Valence, France). We have already reported the effectiveness of this implant in reducing the incidence of postoperative dislocations in revision THAs.[16] The cup is also known as a dual mobility cup or unconstrained tripolar cup.[17,18] Its mode of action has been described in other publications.[16–19]

A few reports on this type of cup for primary THAs have been published in the past but they originate predominantly from French centres associated with the original cup conception.[20–22] Furthermore, data on patients with accumulated risk factors are sparse. The aim of this paper is to present the experience gained outside France and to focus solely on primary THAs judged as having a high risk of dislocation.

Methods

A retrospective review was undertaken of 65 primary THAs in 55 patients (15 men and 40 women) performed between October 2005 and November 2009. The Saturne® DM acetabular implant was only used in cases where the patient had at least one of the documented risk factors for postoperative instability (Table 1).[4,22] Among the 65 cases, there were 52 patients (80%) with at least 2 risk factors and 17 (26%) with at least 3 risk factors. Patients with prior surgery to the ipsilateral hip (23 patients) and those with neuromuscular disease (2 patients) were considered to be at a higher risk than others.

Table 1 Patient related risk factors for postoperative instability[20]

Risk factors	Number of patients
Age ≥75 years	43
Female sex age >70 years	36
Prior surgery	23
ASA grade ≥3	14
Underlying diagnoses	
Avascular necrosis	10
Fractured neck of femur	1
Inflammatory arthritis	1
Neuromuscular disease	2

ASA = American Society of Anesthesiologists

The mean patient age at the time of surgery was 76 years (range: 44–92 years). The mean body mass index was 27.4kg/m^2. Fourteen patients were ASA grade 3 or above. Indications for surgery included primary osteoarthritis (32 hips), fixation failure for fractured neck of femur (21 hips), osteonecrosis of femoral head (9 hips), osteoarthritis secondary to acetabular fractures (2 hips) and primary treatment for hip fracture (1 hip).

The DM implant used consists of a stainless steel outer shell with a highly polished inner surface and articulates with an ultra-high molecular weight polyethylene (UHMWPE) bipolar component (Fig 1). The outer shell is anatomically designed with a superior and posterior lip that is greater than a hemisphere, and an anterior and inferior cut-out that is less than a hemisphere. In constraining the femoral head, the mobile UHMWPE component envelopes more than 50% of the femoral head and its opening diameter is smaller than that of the femoral head (Fig 2). The outer metal shell has a press-fit option (hydroxyapatite plasma sprayed on to a titanium coating) and a cemented option. In our series, 56 cementless hydroxyapatite coated cups were used and 9 cups were cemented in an acetabular cage after bone grafting. We used 39 cementless stems, 13 cemented stems and 13 distally fixed revision stems.

This was a single surgeon series with the senior author being the primary surgeon. Surgery was performed under general anaesthesia in 20 cases and under spinal anaesthesia in 45 cases. A posterior approach to the hip joint was used in all cases. The cup was positioned intraoperatively to achieve version and inclination within the safe zone as defined by Lewinnek *et al.*[23] The external rotators were

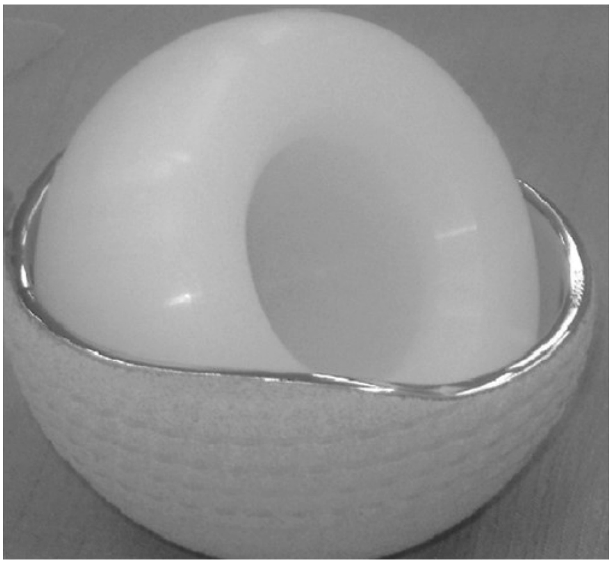

Figure 1 The stainless steel shell with the polished inner surface articulating with the ultra-high molecular weight polyethylene bipolar component

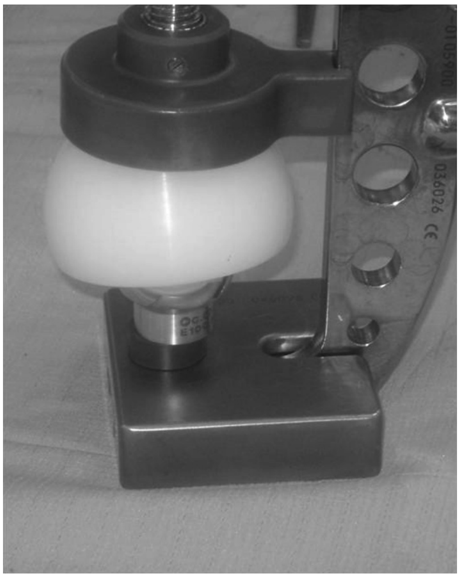

Figure 2 The special device used to lock the head into the liner. Note the head placed under the polyethylene liner. On tightening this device with a screw mechanism, the liner is pushed down and on to the head. The inner diameter of the liner is smaller than the head diameter, which means that once locked in, the head cannot come out.

repaired routinely with absorbable stitches and the capsule when possible.

Patients were followed up at six weeks, six months, one year and annually thereafter. At each visit, plain radiography was performed, and Oxford and Merle d'Aubigné hip scores were calculated. Radiological inclination angles were measured from digital x-rays and loosening was assessed by the criteria described by Johnston *et al.*[24]

Results

The mean follow-up duration was 60 months (range: 36–85 months). At the final follow-up review, 14 patients had died and 1 was lost to follow-up, leaving 40 patients (50 hips) for final assessment. At the final follow-up appointment, no patient had had a dislocation or required revision surgery.

Of the 40 patients, 8 were unable to fill in the hip score questionnaires reliably owing to dementia. The mean Oxford hip score improved from 43.0 (standard deviation [SD]: 11.9) to 26.5 (SD: 8.2) ($p<0.0001$). The mean Merle d'Aubigné pain score improved from 1.4 (SD: 1.8) to 4.9 (SD: 1.5) ($p<0.0001$), the walking score from 2.3 (SD: 1.6) to 3.1 (SD: 1.2) ($p<0.07$) and the absolute hip function score from 5.4 (SD: 3.6) to 10.8 (SD: 2.9) ($p<0.0001$). There have been no clinical or radiographic signs of loosening. The mean abduction angle as measured from postoperative x-rays was 43° (range: 28–66°). There were two instances of early infection (one superficial and one deep), both of which responded to wound washout and intravenous antibiotics, and made an uneventful recovery.

Discussion

The DM concept and the first design of the implant originated in France in the early 1980s.[20,21] However, three decades down the line, outcome reports are still sparse (Table 2).[18,20–22,25–27] We have reported excellent results with this implant in a large series of revision hip replacements.[16] The use of this implant in primary THA has been reported in 7 studies so far with follow-up duration ranging from 12 to 244 months in cohorts varying in size from 45 to 438 patients.[18,20–22,25–27] All but one of these studies have used this cup as the standard in their primary hip replacements. We had strict inclusion criteria, and this implant was only used in patients who were at high risk of dislocation and had at least one risk factor.[22] To our knowledge, this is the first report from the UK.

With a mean follow-up duration of five years, our results are still quite early and it is therefore not possible to

Table 2 Outcome of double mobility implants in other published studies

Study	Implant	Number of procedures	Mean follow-up duration	Dislocation	Aseptic loosening needing revision
Philippot, 2008[18]	SERF	438	204 mths	0	13
Guyen, 2007[22]	Saturne®	167	40.2 mths	0	0
Deburge, 1981[25]	*	45	12 mths	1	*
Semenowicz, 2007[26]	Avantage	113	20.4 mths	0	*
Boyer, 2012[27]	SERF	240	264 mths	74% survival	20
Leclerq, 2008[43]	Evora	200	72 mths	0	0
Lautridou, 2008[44]	Bousquet cup (not specified)	345	198 mths	5	30
Present study	Saturne®	65	60 mths	0	0

*Information not available in abstract. Full paper not in English.

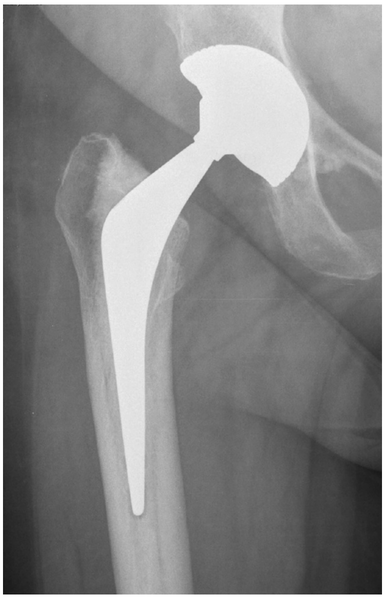

Figure 3 Postoperative radiography of a well fixed, well aligned, uncemented double mobility cup

comment on cup survival. However, it must be emphasised that our aim was to look at the effectiveness of this cup in preventing postoperative dislocation. Our numbers are not big as we had strict inclusion criteria but it is noteworthy that there has been 100% dislocation free survival so far.

Dislocation following THA continues to be a problem for which a completely satisfactory solution has not been found. Several methods have been proposed to prevent hip dislocations with varying degrees of success, including elevated rim liners, constrained liners and large diameter bearings.[28–33]

Large diameter heads theoretically confer some stability by increasing the head–neck ratio and the distance of translation before dislocation can occur.[34] However, despite these theoretical advantages, the majority of clinical studies have been unable to prove this convincingly.[11,35] In a series of 142 dislocations in 6,700 hips, Ali Khan *et al* found no difference in rates of dislocation between femoral implants with diameters of 22mm, 26mm, 28mm and 32mm.[11]

Berry *et al* have shown a lower cumulative risk of dislocation with 32mm heads than with 22mm heads only with the posterolateral approach to the hip.[34] This difference was not significant in anterolateral or transtrochanteric approaches. Other authors have reported greater stability with larger heads.[35]

Acetabular components with elevated liners have been used in an attempt to increase stability.[28] Better results have been reported with this than with the standard liner at the two-year and five-year follow-up visits. However, the difference was not significant. Nevertheless, increased wear debris from the high density polyethylene rim and loosening (due to force transmission through the point of contact on the augmented rim) are cause for concern.

An increased wear rate has been observed at the time of revision surgery with these implants resulting from impingement of the femoral neck against these elevated liners.[36] Constrained liners have been in use ever since introduction of the Sivash prosthesis in 1963.[29,30] These have the advantage of a capture mechanism preventing hip dislocation. On the other hand, the disadvantages are the restricted range of motion and the thin polyethylene, which restrict their use to elderly, low demand patients. There have been reports of failure of these constrained liners and Cooke *et al* have identified three sites of failure: bone–prosthesis interface, liner locking mechanism and head locking mechanism.[37] These lead to loosening of the acetabular component as well as dislocation. The S-ROM® acetabular liner (DePuy, Warsaw, IN, US) has shown dislocation rates of 9–29% and loosening of 4% within three years.[38]

The present study was performed to evaluate the effects of the DM acetabular cup in primary hip arthroplasty on stability in selected patients at high risk of dislocation. We believe that preoperative identification of patients at high risk of dislocation is a crucial step in preventing hip instability. Patient related risk factors have been documented in various studies.[5] Women have been found to have a higher risk of dislocation than men and this has been three times higher five years after surgery.[4] This has been attributed to more compliant soft tissues and greater range of movement. Guyen *et al* considered female sex as a risk factor when associated with an age of more than 70 years.[22]

Mental status is also an important factor as patients with deranged cognitive function will be unable to comply with postoperative instructions and will assume postures that can adversely affect hip stability.[11] Neurological conditions like hemiplegia and parkinsonism also have an adverse impact on hip stability owing to altered muscular balance and tone.

In our study, there was a significant number of patients who had prior hip surgery, mostly fracture fixation. This group of patients is at higher risk of dislocation because of the compromised soft tissues around the hip.[11] At the Mayo Clinic, Woo and Morrey reported a higher rate of dislocation in those who had prior hip surgery (4.8%) than in those without any previous surgery on that hip (2.4%).[2] Failure of fixation of neck of femur fractures has been documented to be close to 20% in recent studies, even in younger patient cohorts.[39,40] The DM implant could be the answer to the problem of hip instability in such a situation.

The indication for the hip replacement procedure has also been documented to influence the dislocation rate. Berry *et al* identified acute fracture, non-union, osteonecrosis of the femoral head and inflammatory arthropathy as carrying a higher risk of dislocation than osteoarthritis.[4] Other investigators have echoed this.[6,8,9,13]

There has been concern that movement of the large polyethylene liner would generate excessive wear.[22] Most of the movement occurs at the smaller head–liner interface rather than the liner–shell interface owing to the lower frictional torque.[17] Retrieval studies show that even when wear at both concave and convex surfaces are taken into consideration, the dual articulation is not associated with increased wear when compared with standard metal-on-polyethylene bearings.[41]

Our dislocation free survival at a mean follow-up of 60 months compares favourably with similar series reported from France. Longer follow-up periods will tell us whether this implant is the answer to the problem of hip instability. We accept that the short follow-up period is a drawback of our study but it has been shown that most dislocations occur in the first three months after surgery.[42] We are aware that this is a relatively small series but, being a new implant, we included only patients with risk factors as mentioned.

Conclusions

Data are still lacking with regard to polyethylene wear rates at the additional bearing surface in the long term. The routine use of these implants for uncomplicated primary THAs is therefore not recommended until further follow-up review is available. The DM acetabulum is still a safe option in patients at high risk of postoperative instability.

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