Outcomes of Dual Mobility Acetabular Cups in Total Hip Arthroplasty Patients

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ABSTRACT

Background: Instability can account for over 20% of all revision total hip arthroplasties (THAs). Although a number of surgical techniques have been developed to limit the number of dislocations, prevention still remains a challenge. More recently, dual mobility (DM) cups have been developed to potentially target this problem. Although this implant design has been shown to have a number of potential advantages in the revision setting, there is limited data in the literature on the use of modular dual mobility (MDM) implants for primary THAs. Therefore, the purpose of this study was to evaluate cup survivorships, patient satisfaction outcomes, and complications of this device used for primary THA.

Materials and Methods: A total of 143 consecutive hips (131 patients) who underwent primary THA using DM prostheses by a high-volume academic surgeon were longitudinally followed up for a minimum of five years (mean: 6 years, 11 months; range, 6 years 3 months to 7 years 5 months). There were 77 women (54%) and 66 men (44%) who had a mean age 65 years (range, 34 to 90 years; SD, 11 years), and the mean body mass index (BMI) was 32 kg/m2 (range, 22 to 52; SD, 8 kg/m2). Patient demographics, (gender, BMI), as well as clinical outcomes were analyzed. Kaplan-Meier analysis was performed to determine aseptic, septic, and all-cause
Despite a number of improvements in surgical techniques, prosthesis dislocation after total hip arthroplasty (THA) continues to remain a leading causative factor for revision.\(^1\)–\(^4\) It is estimated that instability is associated with over 32% of THA-related readmissions, and 17 to 22% of all revision THAs.\(^1\),\(^5\),\(^6\) It is well established that revision procedures are associated with higher costs, increased complications, and decreased patient satisfaction. Therefore, a number of attempts have been made to reduce, and potentially prevent, the need for revision THA. One specific technique is to use large diameter femoral heads (>36 mm) and constrained liners\(^7\),\(^8\) as larger femoral heads can improve stability through an increased head-to-neck ratio.\(^9\) However, this technique has been associated with potential complications such as local tissue reactions. Another potential option is to use constrained liners, yet these liners have been associated with high dislocation and mechanical failure rates.\(^10\)–\(^13\)

**INTRODUCTION**

Modular dual mobility cups (MDM) have been introduced to potentially help reduce the occurrences of hip prosthesis dislocations.\(^14\),\(^15\),\(^16\)–\(^25\) The MDM construct consists of a small femoral head that articulates with a large ultra-high molecular weight (UHMW) polyethylene liner, all of which is seated in the MDM liner and acetabular shell. The smaller femoral head and large UHMW polyethylene dual construct allows for greater hip range of motion, while providing increased stability. These are accomplished by having two points of articulation, 1) between the femoral head and the liner and 2) between the liner and the shell, instead of only one articulating surface between the femoral head and acetabular liner, as is the case with a standard design.\(^9\)

Because of the added stability and range-of-motion attributed to MDM cup designs, their primary application thus far has been in revision THAs. A recent study compared four-year outcomes of 85 revision THA patients that received the MDM cup compared to a 1:2 matched cohort of patients who received a fixed bearing design and found significantly greater overall survivorship for the MDM cohort (97 vs. 95%) (p<0.05).\(^26\) Although analogous findings have also been found in other studies, these studies have focused on revision THAs, leaving a paucity in the literature evaluating the use of MDM liners in primary THA. Therefore, the purpose of this study was to evaluate 1) aseptic, septic, and all-cause survivorship, and 2) mid-term patient satisfaction outcomes of this device in primary THA patients.

**MATERIALS AND METHODS**

**Patient selection**

A total of 143 consecutive hips (129 patients) who underwent primary THA using MDM prostheses by a high-volume academic surgeon between January 4, 2011 and March 1, 2012 were included for analysis. Patients were prospectively followed for a minimum of five years (mean: 6 years, 11 months; range, 6 years 3 months to 7 years 5 months). There were 77 women (54%)
and 66 men (44%) who had a mean age of 65 years (range, 34 to 90 years; SD, 11 years), and the mean BMI was 32 kg/m² (range, 22 to 52; SD, 8 kg/m²). Institutional review board approval was obtained prior to the start of this study.

Implant description
The modular dual mobility cup evaluated in this study was the MDM³X³ Modular Dual Mobility Acetabular System (Stryker, Mahwah, New Jersey). This MDM design consists of a small femoral head (22.2 or 28 mm), a large highly cross-linked polyethylene insert (36 to 58 mm), and a dual construct acetabular shell with an inner liner and a cementless press-fit metal acetabular outer shell. The outer shell is coated with a titanium plasma spray as well as multiple holes for adjuvant screw fixation. Both of these modalities are performed to increase biologic fixation. All patients followed a standard postoperative protocol, including early gradual weight-bearing, standard hip dislocation exercises.

Study endpoints
Implant survivorship, based on septic and all-cause survivorship, was tabulated. Additionally, complications for all patients were reviewed according to the Hip Society’s standardized list of total hip arthroplasty complications. Complications were categorized as either surgical or medical in nature. Management of each complication was also recorded, with particular concern taken if the patient required operative treatment.

Patient satisfaction outcomes were assessed using the Harris Hip Score (HHS) survey. Patients completed their HHS surveys preoperatively and at yearly and final follow-ups. In addition to an overall satisfaction score, extension, flexion, abduction, adduction, external rotation, and internal rotation ranges-of-motion were also assessed by the performing orthopaedic surgeon.

Data analysis
Kaplan-Meier analysis was performed to calculate MDM cup survivorship. Revisions due specifically to cup septic or aseptic loosening or dislocation were determined as survivorship endpoints. Survivorship analysis was performed at final follow up for all patients. Patient’s data was entered into an Excel® spreadsheet (Microsoft Corporation, Redmond, Washington) after removing patient identifiers. All analyses were performed using SPSS version 24 (IBM Corporation, Armonk, New York).

RESULTS

Implant survivorship
Septic survivorship was found to be 99.3% (95% CI: 0.98 to 1.0), while all-cause survivorship was 98.6% (95% CI: 0.97 to 1.0). There were two cases (1%) of revision surgeries; however, these were not related to the MDM cup. Specifically, one patient required reoperation due to femoral stem loosening, which was managed with a modular revision stem. At most recent follow up, the patient had progressed well and had an HHS score of 85 points. The other patient was found to have a deep infection, which was managed with a two-stage revision procedure and antibiotics. The infection was successfully resolved after these management modalities. At most recent follow up, the patient had returned to full activity and had an HHS score of 92 points. All septic and aseptic complications occurred early, within the first three years.

Clinical outcomes
All patients reported successful postoperative outcomes, with 99% reporting HHS scores greater than 80 points. Other complications affecting patient outcomes included two patients who presented with concerns for deep vein thrombi, which were both medically managed, as well as one patient who had a non-fatal pulmonary embolism, which was also medically managed. The final HHS scores for these three patients were 83, 100, and 96 points.

DISCUSSION
Modular dual mobility bearing systems have been shown in the literature to help protect against prosthesis dislocations and improve joint stability. This newer implant design is an alternative to other surgical techniques, such as using large diameter femoral heads (>36 mm) and constrained liners, both of which have their own unique drawbacks. Although a number of studies have reported on the use of dual mobility systems, the majority have focused on this use in revision and not primary THAs. Therefore, the purpose of this minimum five-year follow-up study was to report on the survivorship and patient satisfaction outcomes of patients who received this MDM cup for primary THA. The results of this study revealed excellent aseptic (100%), septic (99.3%), and all-cause survivorship (98.6%), as well as patient satisfaction (overall mean HHS of 95 points).

There are some limitations to this study. This study exclusively evaluated a cohort of patients, all of whom received the MDM cup. Therefore, there was no control cohort from which survivorship or outcomes could be compared. Nevertheless, these results provide a foundation highlighting the potential use of this implant modality for primary THAs and can serve as the basis for future comparative works. Furthermore, this is a single-surgeon, single-center analysis, so all patients received the same standardized, pre-, intra-, and postoperative management which could have an influence on the outcomes evaluated. Large sample size studies performed at multiple institutions would further substantiate and make these results more generalizable.

The results of this study are similar to that of a recent multicenter study that evaluated 453 patients who received the MDM articulation for primary THAs. The group’s aseptic and all-cause survivorship was 99.6% (95% CI: 99.1 to 99.9%). One hip was found to have impingement of an anteverted cup resulting in trunnion notching that required revision, while another hip had deep infection that was treated with a two-stage revision. Epinette et al. also performed a multicenter study and compared the use of the MDM cup in patients greater than or less than 70 years of age. The group found no major prosthetic complications between the two cohorts. Cup survivorship in the younger cohort was 100% while the above 70 cohort was 99.7%. Regarding clinical outcomes, Chughtai et al. reported on 453 patients who underwent primary THA with the MDM prosthesis and found the mean HHS score at mean final follow up of 3 ±1 year to be 94 ±6 points. The above studies report on some of the patients...
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also evaluated in this study. However, the patients evaluated in this study are of a specific subset with minimum five-year follow up.

CONCLUSION

In conclusion, based on the results of this study, dual mobility cups can potentially provide a safe and effective prosthesis for patients undergoing primary THAs. Although, multicenter randomized control trials evaluating comparative cohorts need to be performed, the results of this study provide a foundation for the appropriate use of MDM cups in primary THAs.

AUTHORS’ DISCLOSURES

Dr. Mont is a consultant for, or has received institutional or research support from, the following companies: CyMedica Orthopedics, Inc., Performance Dynamics, Inc., Kolon Pharmaceuticals, Inc., PeerWell, Inc., Sage Products LLC, TissueGene, Inc., OnGoing Care Solutions Inc., DJO Global, MicroPort Orthopedics, Inc., OrthoSensor, Inc., National Institutes of Health (NIAMS and NICHD), Stryker, Johnson & Johnson, Pacira Pharmaceuticals, Inc., and US Medical Innovations. Dr. Mont is on the editorial/governing board of the American Journal of Orthopedics, the Journal of Arthroplasty, the Journal of Knee Surgery, and Surgical Technology International. He is a board or committee member of AAOS.

Dr. Harwin receives financial or material support from Orthopedics, SLACK Incorporated, Stryker, Thieme, Inc., the Journal of Hip Surgery, and the Journal of Knee Surgery.

All other authors have no conflicts of interest to disclose.

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