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## An Early Report of the Use of a Modular Dual Mobility Articulation in Revision Acetabular Reconstruction

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## ABSTRACT

**Background:** Instability remains one of the main problems after revision hip surgery. The aim of this study was to review the clinical, radiological, and patient-reported outcomes with the use of modular dual-mobility articulation for revision acetabular reconstruction and investigate the risk of fretting corrosion by measuring serum trace metal ion levels.

**Methods:** Sixty consecutive patients with a minimum of 24-month follow-up after the insertion of a modular dual-mobility (Stryker, Mahwah, NJ) cup at the time of revision hip surgery were identified. Follow-up included clinical and radiological patient review and functional outcome measures, and a subset of patients had their metal ion (cobalt and chromium) levels checked.

**Results:** At the most recent follow-up, 5 patients had died, 3 patients have been revised because of ongoing instability, and 3 patients have had revision surgery due to infection. Overall functional outcome (mean Western Ontario and McMaster Universities Osteoarthritis Index function 76, University of California, Los Angeles 5.6, mean Oxford 74.7, Short Form-12 physical 41.6/mental 53.3) and overall pain relief (mean Western Ontario and McMaster Universities Osteoarthritis Index pain score 78.3) scores were good. The mean satisfaction score was 78 of 100. The median serum trace metal chromium and cobalt levels at the most recent follow-up were 0.4 µg/L (range 0.1–6.1 µg/L) and 0.42 µg/L (range 0.21–9.42 µg/L), respectively. The survival with revision as the end point was 90%.

**Conclusions:** Dual-mobility cups with modularity represent an excellent option for the patient having revision hip surgery at high risk of instability. This series presents good patient-reported outcome measures and a low complication and revision rate.

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Instability remains one of the main problems following revision hip surgery [1,2]. Dealing with the unstable total hip arthroplasty (THA) is a challenge and several strategies are currently available such as the use of large heads [3,4]; the use of constrained liner [5–7]; and the use of tripolar liners [8,9]. However, all these techniques are associated with variable failure rates. The dual

mobility (DM) articulation offers yet another solution to this problem and has long been used in Europe with good results [10]. DM cups with modularity have recently been introduced in North America for clinical use [11]. The advantages include the ability to initially use screw fixation for the shell in the challenging revision acetabulum and then the DM articulation confers increased stability, without the restriction, potential impingement, and therefore stress transfer and risk aseptic loosening of associated constrained liners [12–14].

In DM articulations, a small-diameter femoral head is snapped into a larger head made of polyethylene. This larger polyethylene head articulates against an acetabular component with a highly polished metal articular surface. This metal articular surface may be the inner surface of a monoblock acetabular shell (standard DM) or a separate chrome-cobalt modular component housed inside a titanium modular

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acetabular shell known as a modular dual mobility (MDM) cup. In the latter case, the mating of the cobalt-chromium metal liner inside the titanium shell, introduces a mechanism with potential source of fretting corrosion involving that junction. This phenomenon has been reported by the use of other modular total hip components, such as between the taper and femoral head or between femoral stem and modular neck, leading to release of metal ions, which can be measured locally as well as systemically [15]. No studies have conclusively investigated fretting corrosion in the MDM acetabular shells.

The aim of this study was to review the clinical, radiological, and patient-reported outcomes with the use of MDM articulation for revision acetabular reconstruction. We also investigated whether the modular acetabular components of the DM articulation increase the risk of fretting corrosion by measuring serum trace metal ion levels in a subset of these patients, given recent concerns identified in a series of cups used in primary total hips [16].

## Methods

Institutional review board approved this retrospective cohort study. The Adult Reconstruction Database at our institution was used to identify all patients who had insertion of an MDM at the time of revision hip surgery between October 2011 and November 1, 2014. Only patients with a minimum follow-up of 24 months by November 2016 were included in the study. All patients had an MDM cup inserted because either they were having a revision because of a diagnosis of recurrent instability or they were felt to be at increased risk of dislocation at the time of their revision surgery. Example of patients considered to be at increased instability risk if they had insufficient abductors at the time of revision or intraoperative assessment of stability at the time of revision suggested that the patient was unstable at less than 45° internal rotation despite appearing to have acceptably orientated components. The MDM (Stryker, Mahwah, NJ) shells were used in all cases.

All patients were contacted via mail or telephone to complete functional outcome scores (Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC], Short Form-12 [SF-12], Oxford Hip Score, satisfaction scale, and University of California, Los Angeles [UCLA] scores). The satisfaction scale was individually measured for pain, function, recreation, and overall satisfaction on a scale of 1 to 4 (very satisfied, somewhat satisfied, somewhat dissatisfied, and very dissatisfied.) for a maximum score of 100% and a minimum score of 0%. Preoperative functional outcome scores were not available. Demographic data, operation notes, clinic notes, and X-rays (preoperative, postoperative, and follow-up) were reviewed for all patients. Clinical failure was defined as revision of the DM articulation due to any cause.

Radiological evaluation consisted of anteroposterior and iliaco-oblique views of the pelvis and a lateral view of the hip. Radiographic signs of osseointegration between host bone and the acetabular shell were assessed according to the criteria suggested by Moore et al [17].

A subset of patients was invited to have metal ion (cobalt and chromium) levels checked. Blood ion levels could only be taken at the base hospital. Due to the geographical size of the region covered by our tertiary referral adult reconstruction service and distances that would have to be travelled by patients, only those who were able to attend the base hospital for blood tests were invited to have their metal ion levels checked for this study. For those who did have blood metal ion levels performed, the serum was frozen at –20°C and then sent for processing at the Trace Elements Laboratory, Department of Laboratory Medicine, London Health Sciences Centre, London, Ontario, Canada, using high-resolution inductively coupled plasma mass spectrometry.

Statistical analysis was performed using SPSS version 15.0 (SPSS, Chicago, IL). Data were expressed as means, medians, range, and standard deviations.

## Results

Sixty patients in total were identified as having an MDM inserted during their revision hip procedure between October 2011 and November 2014. All procedures were performed by 1 of 4 experienced adult reconstruction surgeons. The mean age at the time of surgery was 65.5 years (range, 41–88 years). There were 34 female and 26 male patients. The mean body mass index was 30.9 (range, 22.1–40.3; standard deviation = 6.3).

Indications for surgery in all 60 patients were recurrent instability in 23 (38.3%), aseptic loosening in 17 (28.3%), pseudotumor in 9 (15%), periprosthetic joint infection in 7 (11.7%), painful metal-on-metal (MoM) THA in 2 (3.3%), hemiarthroplasty with severe heterotopic ossification in 1 (1.7%), and severe trochanteric pain from increased global offset in 1 (1.7%).

To assess where MDM usages fit in our overall revision hip practice, we assessed in what proportion of the overall revision burden was these MDM cups used. In the same time period (October 2011 to November 2014), a total of 585 revision hip procedures were performed in the adult reconstruction unit. One hundred twenty-eight of these revision hip cases were performed for a diagnosis of instability. The treatment options taken for these 128 revision cases performed for instability are displayed in Table 1. The option of MDM was used for 23 of these 128 procedures. Surgeon preference was the reason a DM articulation was used primarily because of the perceived higher risk of failure of constrained sockets.

In the majority of 60 MDM cases, only the acetabulum was revised. Forty-seven (78.3%) were acetabular-only revisions. In the 13 (21.7%) where the stem was also revised, a Wagner SL revision stem (Zimmer, Warsaw, IN) was used in 8 cases, a GMRS (Stryker, Mahwah, NJ) in 4 cases, and an SROM (DePuy, Warsaw, IN) in 1 case. Most commonly, 2 or 3 screws were used to fix the acetabular shell. In 4 cases, the acetabular revision consisted only of exchanging the liner to a cobalt-chrome liner in an already well-fixed and appropriately orientated titanium shell (Stryker, Mahwah, NJ). A size 28-mm-diameter cobalt-chrome inner head was used in all cases except one where ceramic head of same size was used. In all cases, the heads were from the same manufacturer as the stem.

At most recent follow-up, 5 patients had died (8.3%). Three (5%) patients have been revised because of ongoing instability and 3 (5%) patients have had revision surgery due to infection. Of the 3 patients revised for instability, 2 had previous surgery for pseudotumor and were found to have evidence of recurrent pseudotumor at the time their MDM was revised to a constrained liner and a ceramic head. One further patient has symptomatic subluxation of

**Table 1**  
Types of Revision Hip Procedure Performed for a Diagnosis of Instability Between October 2011 and November 2014.

Type of Revision Hip Surgery Performed for a Diagnosis of Instability	Number of Procedures
Constrained liner	44
Revision of acetabular cup and large-diameter femoral head used (±femur revision)	29
Modular dual mobility	23
Liner exchange	19
Anatomic dual mobility	8
Femoral sided revision only	5
Total	128

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