Revision of Failed Hip Resurfacing and Large Metal-on-Metal Total Hip Arthroplasty Using Dual-Mobility Components

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Abstract: Revision of metal-on-metal (MoM) total hip arthroplasty (THA) or hip resurfacing is associated with high complication rates. The authors propose dual-mobility components as a surgical option and present short- to mid-term results of MoM hips revised with dual-mobility components. Eighteen consecutive hips that underwent revision of MoM THA or hip resurfacing using dual-mobility components were identified. At final follow-up (mean, 17.5 months), the visual analog scale, modified Harris Hip Score, and SF-12 scores had all improved (P<.05, P<.01, and P<.05, respectively). There were no dislocations or other complications. Revision of failed MoM THA or hip resurfacing using a dual-mobility device is an effective strategy. [Orthopedics. 2015; 38(6):369-374.]

Large-head metal-on-metal (MoM) hip arthroplasty has been linked to an unacceptably high failure rate. For example, 5-year failure rates have been reported from as low as 6.2% to as high as 49% for the ASR implant (DePuy, Leeds, United Kingdom).1-3 Furthermore, revision surgery for failed large-head MoM total hip arthroplasty (THA) or hip resurfacing has been a challenge. Previous studies have reported low patient satisfaction as well as high failure and complication rates, including dislocation, infection, and aseptic loosening. Major complications have been reported to affect 38% of revision surgeries for failed MoM THA, with a dislocation rate of 28%.4 In revision for MoM hip resurfacing, major complications occurred in 50% of cases for pseudotumor and in 14% of cases of revision for all other reasons.5 Dual-mobility total hip components have been used successfully in Europe for more than 25 years; however, they have only recently been approved by the Food and Drug Administration for use in the United States. The dual-mobility articulation consists of a 28- or 22-mm metal femoral head that snaps into a mobile polyethylene liner. This polyethylene liner has 2 articulating surfaces: an outer soft-on-hard articulation with the acetabular shell and an inner hard-on-soft articulation with the metal femoral head (Figure 1). This design has been shown to have lower wear rates as well as low dislocation rates.6,7 Furthermore, in this construct, the polyethylene liner functions as a large femoral head, increasing the

Figure 1: A dual-mobility device (Modular Dual Mobility X3; Stryker, Mahwah, New Jersey) with acetabular shell, outer modular metal liner, inner mobile polyethylene liner, and ceramic head. (Image courtesy of Stryker.)
jump distance required to dislocate and increasing functional range of motion. Multiple studies have shown low dislocation rates with dual-mobility liners in both primary and revision THA.8–10

Previous authors have proposed using dual-mobility components for revision of MoM articulations with large femoral heads.11,12 Using the dual-mobility device allows the surgeon to maintain a large femoral head size similar to the native head size and potentially increase the range of motion and stability postoperatively compared with standard THA. Options for revision depend on the integrity and stability of the femoral and acetabular components. When both components fail, full revision is required; however, when only one component is affected, single-component revision has been proposed.11,13,14

The authors report single- and both-component revision of large-head MoM THAs and hip resurfacings. The purpose of this study was to report early results, complications, and clinical outcomes in revision THA for large MoM articulations using the dual-mobility liner. The authors hypothesized that revision of large MoM THAs and hip resurfacing with dual-mobility liners would be a simple, effective option with a low complication rate.

Materials and Methods

Patient Selection

Once institutional review board approval was obtained, 18 consecutive large-head (>40 mm) MoM THAs or hip resurfacings in 17 patients undergoing revision THA using dual-mobility liners between April 2011 and April 2013 were investigated. Patients were included if they were 18 years or older and undergoing revision THA for failed hip resurfacing or MoM THA using dual-mobility liners. Exclusion criteria included revision surgery for infection and revisions of small metal heads less than 40 mm in diameter.

Surgical Technique

All operations were performed by 2 adult reconstruction fellowship-trained orthopedic surgeons. Fifteen revision THAs were performed via the Hardinge approach and 3 were performed via a posterior approach. All hip resurfacings had the femoral side revised to a standard cementless medial-lateral taper femoral stem. Existing components were revised based on pre- or intraoperative signs of loosening or malpositioning. A Modular Dual Mobility X3 liner (Stryker, Mahwah, New Jersey), Anatomic Dual Mobility X3 liner (Stryker), or Active Articulation Dual Mobility E1 liner (Biomet, Warsaw, Indiana) was size matched to the existing acetabular shell and inserted onto a 22- or 28-mm metal or ceramic head.

Follow-up and Outcomes

A retrospective chart review was performed to ascertain surgical indications, concomitant procedures, component sizes, pre- and postoperative serum metal ion levels, pre- and postoperative clinical and radiographic data, and perioperative complications, including infection, dislocation, mechanical failure, and reoperations. Hospital length of stay and postoperative blood transfusions were recorded. Complications were identified by assessing the patient’s clinical course, including acute events, per-incisional infections, persistent wound drainage, purulence, periprosthetic joint infection, dislocations, mechanical failures, and revision procedures.

All patients were followed postoperatively during standard time intervals. Follow-up consisted of a physical examination, with emphasis on the patient’s range of motion, signs of infection, and strength and stability, as well as the completion of self-reported questionnaires. Visual analog scale (VAS), modified Harris Hip Score (mHHS), and SF-12 questionnaires were administered pre- and postoperatively to assess functional outcomes after THA revision with a dual-mobility component. In addition, radiographs were reviewed to observe hardware complications, including malpositioning, loosening, osteolysis, periprosthetic fracture, subluxation, or dislocation.

Results

Patient Demographics

Eighteen large-head MoM hip arthroplasties were identified in 17 patients (12 male [71%] and 6 female [29%]). There were 10 hip resurfacings and 8 MoM THAs. At the time of surgery, the average age of this patient population was 50.6 years (range, 25–71 years), and the mean body mass index was 26.5 kg/m² (SD, 5.35 kg/m²). The most common condition predisposing to revision was pseudotumor or adverse reaction to metal debris (8 cases) (Table).

Follow-up

The average follow-up time was 17.5 months (range, 6–32 months), with 15 of the 18 revision THAs having at least 1 year of follow-up. Implant failure and reoperation were considered to be the survival analysis endpoint.

The types of revision procedures and components used are detailed in the Table. Two hips underwent isolated acetabular component revision, 7 underwent isolated femoral component revision (Figure 2), and another 7 underwent both-component revision. In 1 patient, the 2 hips underwent only head and liner exchanges with retention of both femoral and acetabular components (Figure 3). This translates to 4 retained femoral components and 9 retained acetabular components.

Regardless of predisposing condition, a statistically significant difference was observed when comparing patients’ pre- and postoperative clinical outcome measures. The mean VAS score decreased from 9.03 preoperatively to 3.67 postoperatively (P<.00001). The mHHS increased from 28.08 preoperatively to 66.2 postoperatively (P<.00005). The SF-12 scores demonstrated a similar trend, increasing from 26.4 for...
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debris has been especially fraught with recurrent dislocations and infection.\textsuperscript{4,5} Some have postulated that the higher dislocation rate may be related to the decrease in femoral head size when revising large MoM articulations to smaller metal-on-polyethylene articulations.\textsuperscript{5}

Originally conceived to prevent dislocations, dual-mobility components have a long track record in Europe in primary and revision THA and are associated with low dislocation rates and good clinical outcomes.\textsuperscript{17-21} The large polyethylene mobile liner mimics a large femoral head similar to the patient’s native anatomy while avoiding the complications specific to MoM articulations and metal ion debris. This allows for restoration of more anatomical mechanics and motion about the hip.

These implants have recently become available in North America, and femoral-component revision of large-head MoM articulations using dual-mobility components has previously been suggested. Within a larger study, Pritchett\textsuperscript{11} reported one group of 14 MoM hip resurfacerings with femoral head size greater than 44 mm that underwent femoral-side-only revision with dual-mobility components. There were no complications or re-revisions in this group. Verhelst et al\textsuperscript{12} also proposed femoral-only revision of painful, large MoM articulations using dual-mobility liners. In this case series, all 3 patients reported improved outcomes, higher satisfaction, decreased metal ion levels, and no complications at 6-month follow-up. In both of these studies, revisions were performed while retaining the acetabular components.

Options for revision depend on the integrity and stability of the femoral and acetabular components. When both components fail, full revision is required; however, when only one component is affected, single-component revision has been proposed.\textsuperscript{11,13,14} While acetabular-only revisions have had more difficulty, femoral-only revisions have provided some limited success with outcomes similar to revision of both sides.\textsuperscript{13} Therefore, in circumstances where the acetabular component remains well fixed and oriented, isolated femoral component revision may be performed successfully.

The outer bearing surface of the polyethylene in a dual-mobility system provides a large articulation that can be size matched to an intact acetabular component. Without the dual-mobility liner, acetabular revision is often required to create a smaller metal-on-polyethylene articulation. In the current series, revision of one or both components was performed based on signs of loosening and/or malpositioning of the components on preoperative radiographs and during intraoperative assessment. All hip resurfacings had the femoral side revised to a standard femoral stem. Seven hips underwent revision while retaining the acetabular component.

Single-component revision has several advantages over both femoral and acetabular component revision; namely, single-component revision is a less invasive operation. This translates to lower morbidity and shorter surgical time. Revision and explantation of well-fixed components is a highly morbid procedure involving loss of existing bone stock and increased blood loss. Moreover, this type of extensive surgery can significantly increase operative time, risk of surgical-site infection, and hospital costs. In the current study, there were no blood transfusions among the 11 hips undergoing single-component revision or head and liner exchange.

As an example, the total cost of a revision acetabular shell and liner is approximately 3 times that of the dual-mobility liner alone at the authors’ institution. Moreover, previous studies have proved that there are added costs of...
increased operative time, increased hospital length of stay, and more frequent blood transfusions accompanying a more complex and morbid surgery (ie, full acetabular revision).\textsuperscript{22,23} Furthermore, the low complication rate (ie, dislocation rate after revision THA) associated with the use of dual-mobility liners may reduce hospital readmission. A study performed in 2003 demonstrated that hospitals lose an average of $5402 for each revision THA performed.\textsuperscript{23} Judicious use of dual-mobility liners may help alleviate this deficit.

The authors have reported outcomes and complications of revision for both large-head MoM THAs and hip resurfacings with no exclusions based on previous head size. The data of this study support previous claims and suggest that short- to mid-term outcomes using dual-mobility components have significantly improvedVAS, mHHS, and SF-12 scores. Furthermore, the authors have shown that this simple surgical strategy has relatively low morbidity and complication rates. In this series, none of the patients experienced postoperative instability, mechanical failure, or infections.

Factors other than component selection may have contributed to the low failure rate. The majority of the operations were performed via the Hardinge approach, which has been associated with a lower dislocation rate. However, all cases done via a posterior approach included a posterior soft tissue repair, which has been shown to bring dislocation rates to levels similar to those of the direct lateral approach.\textsuperscript{24} The 2 surgeons who performed all of these procedures are both experienced, high-volume, adult reconstruction fellowship-trained surgeons, which also may have contributed to a higher success rate. However, this is a relatively simple surgical strategy, and the authors hypothesize that a lower-volume, less-experienced surgeon would be able to replicate these results.

Further, excellent postoperative acetabular cup positioning also contributed to this low failure rate. The mean acetabular cup inclination measured 39.2°, likely contributing to the low dislocation rate. The authors were unable to accurately measure acetabular anteversion and component offset. These factors also play a major role. Intraoperative assessment of cup inclination and anteversion was a major criterion for retaining the primary acetabular component. Offset and soft tissue tension were also assessed intraoperatively as part of stability testing prior to final implant selection.

This retrospective study has limitations. Because dual-mobility components have only recently become an option in the United States, the authors only report short- to mid-term follow-up. The study population is not large enough to power comparisons between groups of different types of revisions. The authors also did not compare patients receiving dual-mobility components with those receiving standard total hip components. Further prospective studies are planned and required to prove the effectiveness of this procedure.

Dual-mobility components appear to be a simple yet powerful and cost-effective solution to failed large-head MoM hip arthroplasty and may allow lower morbidity with single-component revision.

REFERENCES


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