Perioperative factors associated with increased length of stay after revision of metal-on-metal total hip arthroplasty

Jonathan H. Garfinkel^a, Brian P. Gladnick^{c,*}, Cole S. Pachter^b, Niall H. Cochrane^a, David W. Romness^{a,b}

^a Georgetown University School of Medicine, 3900 Reservoir Road NW, Washington, DC, 20007, USA

^b OrthoVirginia, Adult Hip and Knee Reconstruction, 1635 N. George Mason Drive, Suite 310, Arlington, VA, 22205, USA

^c W.B. Carrell Memorial Clinic, Adult Hip and Knee Reconstruction, 9301 N. Central Expressway, Suite 500, Dallas, TX, 75231, USA

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ABSTRACT

Objective: To investigate patient factors influencing length-of-stay (LOS) after revision metal-on-metal (MoM) total hip arthroplasty (THA).

Methods: We reviewed 23 hips undergoing revision of a MoM THA with minimum 2-year follow-up. A multiple linear regression was calculated to predict LOS using multiple variables.

Results: Average length of stay (LOS) was 2.1 days. Multiple linear regression analysis identified a significant correlation between presence of an abductor injury ($\beta = 0.8886$; $p < 0.0001$), patient age ($\beta = -0.4452$, $p = 0.0083$), and pre-revision head size ($\beta = 0.4082$; $p = 0.0172$) with LOS ($R^2 = 0.6351$, $p = 0.0002$).

Conclusion: Patients with abductor injury, larger femoral heads, and younger age are at risk for longer LOS.

1. Introduction

Metal-on-metal (MoM) bearing surfaces have previously been used in total hip arthroplasty (THA) due to their superior wear properties, as well as the ability to use larger femoral heads to improve stability.¹ However, in the past decade the use of MoM has decreased significantly due to the risk of adverse reaction to metal debris (ARMD) and early implant failure.^{2–4} Because of the prior widespread use of MoM implants in the United States, there exists a growing burden of revision surgery due to failure of these implants, and the presence of ARMD in these patients presents specific perioperative challenges.^{2–6}

ARMD is characterized by lymphocyte infiltration of the periarticular tissues, resulting in multiple potential effects including osteolysis, joint effusion, and destruction of bone and soft tissue.^{5,7–10} Previous authors have reported increased risks of post-operative complications and re-revision in patients undergoing revision of MoM THA, particularly in those patients undergoing revision specifically for ARMD.^{11–14} However, less is known regarding what factors impact recovery for MoM revision patients in the immediate postoperative period, particularly regarding length of stay in the hospital. As the burden of revision surgery for MoM THA implants grows in an increasingly cost-conscious environment, identifying what perioperative patient

demographic factors affect length of stay (LOS) in the hospital after revision surgery is an important consideration for arthroplasty surgeons.

To address this, we conducted a retrospective review of a prospectively collected revision total joint arthroplasty database at our institution asking the following research questions: 1) what perioperative factors in patients undergoing revision of metal-on-metal total hip arthroplasty affect hospital length of stay after surgery; 2) what is the incidence of major complications (infection, dislocation) and re-revision after MoM THA revision surgery; and 3) what are the patient-reported clinical outcomes after MoM THA revision surgery?

2. Methods

2.1. Study design

This was a retrospective review of a prospectively collected revision total joint replacement registry at a high-volume referral center. Approval for the study was obtained by the Institutional Review Board (IRB) at our hospital center prior to its commencement. We included consecutive patients undergoing revision of a metal-on-metal (MoM) total hip arthroplasty (THA) by a single arthroplasty specialist between

* Corresponding author. Attending Orthopaedic Surgeon, W.B. Carrell Memorial Clinic, Adult Hip and Knee Reconstruction, 9301 N. Central Expressway, Suite 500, Dallas, TX, 75231, USA.

E-mail addresses: jhg71@georgetown.edu (J.H. Garfinkel), bgladnick@carrellclinic.com (B.P. Gladnick), cs64@georgetown.edu (C.S. Pachter), nhc8@georgetown.edu (N.H. Cochrane), david.romness@orthovirginia.com (D.W. Romness).

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February 2012 and December 2015. These inclusion criteria initially returned a population of 24 hips in 23 patients. One patient was excluded for having less than two years of follow up, resulting in a final study population of 23 hips in 22 patients undergoing revision of a MoM THA with minimum 2-year follow-up.

In all cases, pre-operative workup demonstrated a painful THA with elevated serum metal (Co/Cr) ions and an absence of infection. Sixteen hips underwent acetabular component revision for a recalled acetabular implant (ASR™, Depuy Synthes, Warsaw, IN); four hips underwent modular head-liner exchange to a highly cross-linked polyethylene liner and ceramic head in the setting of a well-fixed, well-positioned acetabular component (PINNACLE®, Depuy Synthes, Warsaw, IN); two hips underwent acetabular component revision for a well-fixed, well-positioned acetabular component in which the modular CoCr liner was cold-welded to the implant and could not be dislodged (PINNACLE®, Depuy Synthes, Warsaw, IN); and one hip was a previous hip resurfacing (Birmingham Hip Resurfacing, Smith & Nephew, London, UK) in which the acetabular component was revised and a primary femoral stem was placed. All revision surgeries were performed through a posterior approach to the hip.

The electronic medical records and hospital charts of the study patients were retrospectively reviewed. Perioperative baseline demographic data were collected and are included in Table 1. We additionally recorded pre-revision and post-revision head size, and noted whether the cup was revised, versus simple head/liner exchange. For each patient, pre-operative anteroposterior radiographs were reviewed and the abduction angle of the cup was recorded. We also recorded whether an injury to the abductor was observed at the time of surgery, defined as partial tearing or partial detachment of the abductor tendon near its insertion at the greater trochanter. Using these criteria, a total of four hips were noted to have abductor damage, three in patients undergoing cup revision and one in a patient undergoing limited head/liner exchange. There were no full-thickness tears or bald trochanters, and in all cases the injury was directly repaired with non-absorbable sutures. In no case was a constrained liner required.

The primary outcome of our study was the length of patient stay (LOS) in the hospital, calculated from the date of admission to the date of discharge. A multivariate linear regression was calculated to predict LOS after surgery based on patient demographic and perioperative variables as detailed below. As secondary outcomes, we determined the

incidence of major complications in our cohort, including infection, dislocation, and re-revision during the minimum 2-year follow-up period. Finally, as an additional secondary outcome, we determined clinical outcomes for each patient via the joint replacement relevant short form of the hip disability and osteoarthritis outcome score (HOOS, JR).¹⁵

2.2. Statistical analysis

All data were entered, stored, and analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and StatTools (CUHK, Hong Kong, China). A multivariate linear regression was calculated to predict length of hospital stay (LOS) after surgery based on 1) presence of abductor injury, 2) patient age, and 3) pre-revision head size. We also analyzed gender, BMI, pre-revision cup abduction angle, and revision type (cup revision versus head/liner exchange) in our model to determine if there was any correlation with LOS. Statistical significance was set at $p < 0.05$ in all cases.

3. Results

3.1. Length of stay

Average length of stay (LOS) across the entire cohort was 2.1 days (range 1–4 days). Multiple linear regression analysis identified a significant correlation between presence of an abductor injury noted at the time of revision surgery ($\beta = 0.8886$; $p < 0.0001$), patient age ($\beta = -0.4452$, $p = 0.0083$), and pre-revision head size ($\beta = 0.4082$; $p = 0.0172$) with length of stay in the hospital ($R^2 = 0.6351$, $p = 0.0002$) [Table 2]. The remainder of the variables analyzed did not demonstrate a statistically significant effect in predicting LOS when added into the model (data not shown). Based on our model, after revision of metal-on-metal THA the patients' predicted LOS = $2.1143 + (\text{Abductor Injury [Yes} = 1, \text{No} = 0] \times 1.5323) - (\text{Age [Years]} \times 0.0441) + (\text{Head Size [mm]} \times 0.056)$.

3.2. Complications and clinical outcomes

There were no cases of infection (0/23 hips, 0.0%) observed in this cohort over a mean follow-up period of 3.9 years (range 2.0–5.6 years). There was one dislocation event (1/23 hips, 4.3%), in a patient who had undergone a cup revision and was noted to have an abductor tear at that time of surgery; this was treated with closed reduction with no further instability events. One patient was indicated for re-revision (1/23 hips; 4.3%) during the study period; this patient had undergone cup revision that subsequently was indicated for re-revision due to aseptic loosening of the acetabular component, at 8 months post-operatively. At a mean follow-up of 3.9 years (range 2.0–5.6 years), the average HOOS, JR score for the overall cohort was 79.7 (range 39.9–100). We did not identify a significant correlation between HOOS, JR score and any of the perioperative variables previously mentioned (data not shown).

Table 2

Multivariate linear regression analysis of demographic and perioperative variables as predictors of patient length of stay. Beta values shown demonstrating how strongly each predictor variable influences the model.

Variable	Standardized Coefficient (Beta)	p Value
Length of Stay (days); ($R^2 = 0.6351$)		0.0002
Presence of Abductor Injury	0.8886	< 0.0001
Age	−0.4452	0.0083
Head Size (pre-revision)	0.4082	0.0172

Table 1
Perioperative demographic variables.

Variable	N = 23 revisions
Age (mean, range)	63.7 (47.8–76.4)
Gender (%)	
Male	10/23 (43.5%)
Female	13/23 (56.5%)
Body Mass Index (BMI) (mean, range)	27.9 (20.9–43.3)
Operative side (%)	
Right	16/23 (69.6%)
Left	7/23 (30.4%)
Cup Abduction Angle, pre-revision (mean, range)	49.2° (34.0°–66.9°)
Head Size (median, range)	
Pre-revision	46 mm (36 mm–55 mm)
Post-revision	40 mm (32 mm–44 mm)
Revision Type (%)	
Cup revision	18/23 (78.3%)
Head/liner exchange	4/23 (17.4%)
Cup and Stem revision	1/23 (4.3%)
Abductor Injury noted intra-op	4/23 (17.4%)

4. Discussion

In this retrospective review of our institution's prospectively collected total joint replacement database we found that abductor injury, pre-revision head size, and patient age are significantly correlated with hospital length of stay after MoM THA revision. In our model, both presence of an abductor injury and increasing pre-revision femoral head size predicted a longer LOS, while increasing patient age was associated with a shorter LOS. The remainder of the variables analyzed did not significantly contribute to the model for predicting LOS after surgery. Of all perioperative variables analyzed, presence of an abductor injury at the time of surgery had the strongest effect on our model ($\beta = 0.8886$; $p < 0.0001$), increasing the predicted LOS by approximately 1.5 days.

A full understanding of patient demographic factors and the etiology of revision THA is important to allow arthroplasty surgeons to mitigate complications and improve surgical outcomes.^{16–23} Abductor injury is well established as a cause of complications and morbidity in revision THA patients, in both the MoM population and non-MoM populations.^{17,18} In patients with ARMD an inflammatory pseudotumor may form, resulting in damage to the surrounding soft tissues. Additionally, the abductors may stretch, partially tear, or even avulse from the greater trochanter as a consequence of ARMD, leading to worsening hip pain, abductor weakness, and instability of the THA construct.^{13,20,21,23} A 2013 study by Wetters and colleagues report that, in a group of THA patients with any bearing surface, those with an abductor injury were more than twice as likely to dislocate after undergoing revision surgery.¹⁷ In the setting of MoM THA, Liow and colleagues have demonstrated a significant association between abductor injury and poor outcomes after revision surgery for ARMD.¹⁸ We believe these data are consistent with the present study, which demonstrates that the presence of an abductor injury increased the predicted LOS in our model by approximately 1.5 days.

Previous authors have demonstrated that advanced patient age is associated with higher risks of perioperative complications and an extended length of stay, particularly in octogenarians.^{24,25} Interestingly, in the present study our model predicts a shorter length of stay as age increases. This is counterintuitive, as one would expect older patients to have an increased incidence of comorbidities and complications, thereby necessitating a longer LOS in the hospital. However, our patient population was relatively young (mean age 63.7 years, range 47.8–76.4 years); the lack of octogenarians in our series may have prevented us from recognizing longer LOS in advanced ages. Alternatively, it is conceivable that younger, more active patients may place increased demand on the MoM implant, generating faster metal wear and more tissue damage than older, less active patients, which could subsequently explain a slower recovery post-revision and longer LOS. Additional studies examining the relationship between revision outcomes and patient age in the MoM population would be needed to definitively address this issue.

The finding of our model that increasing pre-revision femoral head size is associated with longer predicted LOS may be a consequence of the relationship between head size in MoM THA and ARMD. Larger femoral heads have been shown to be associated with increased rates of revision for ARMD, which in turn is a risk factor for poorer outcomes after revision.^{11,12,19,20} The association we found between pre-revision head size and increased length of stay thus may indirectly reflect the effect of ARMD on immediate postoperative recovery, similarly to the way it impacts long-term revision outcomes.

Complication rates in our population (one dislocation [4.3%], one re-revision [4.3%]) were similar to those seen in prior studies, which have reported re-revision rates of 5–19%.^{11,18,21} In their series of 20 MoM THA revisions in 19 patients, Rahman et al. report two major complications (one foot drop, one superficial infection) and one revision for recurrent dislocation. Our findings of overall satisfactory patient reported outcomes in the form of HOOS, JR (mean 79.7; range

39.9–100) are also consistent with prior studies^{21,22}; in the previously discussed report by Rahman et al., the mean postoperative Harris Hip Score for the cohort was 83.25 (SD 10.08).²¹

Our investigation has a number of limitations. First, it is subject to the selection bias inherent in any retrospective, observational study. We attempted to mitigate the effect of selection bias by reviewing a prospectively collected, consecutive series of patients with pre-determined inclusion and exclusion criteria. Another potential limitation is our small sample size, which may have rendered our study underpowered to find significant effects of some of the perioperative variables on patient LOS. However, our sample size is consistent with others in the published literature,²¹ and our study was sufficiently powered to demonstrate a significant effect of abductor injury, patient age, and pre-operative femoral head size on hospital length of stay, which we feel is important information for arthroplasty surgeons who perform MoM THA revisions. We feel that a strength of this study is that all cases were performed by a single arthroplasty specialist using a standardized technique and perioperative protocols, thereby helping to limit additional variation that may affect patient outcomes.

Our study demonstrates that patients with injury to the abductor mechanism, larger pre-revision femoral heads, and younger age are at risk for longer hospital stays after MoM THA revision. These findings, particularly in regard to abductor injury and femoral head size, complement the existing data regarding long-term outcomes in revision MoM THA. In addition to helping to set patient expectations, length of stay data is of interest to surgeons and institutions concerned with hospital-acquired complications, resource utilization, and cost containment. Future studies should be undertaken to further elucidate factors contributing to extended LOS, as well as to understand the risk of perioperative, in-hospital, and short-term postoperative complications. This will allow surgeons to continue to refine this challenging procedure and further improve patient outcomes.

Conflicts of interest

The authors have no conflicts of interest to disclose pertaining to this manuscript.

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