High Rate of Infection After Aseptic Revision of Failed Metal-on-Metal Total Hip Arthroplasty

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Abstract

Background Evidence suggests some metal-on-metal (MOM) THAs have higher rates of failure and subsequent revision than other bearing surfaces. However, there are few studies demonstrating how these patients fare after revision. **Questions/purposes** We asked: (1) What is the short-term survivorship of revision THA in patients whose index THAs employed MOM bearings? (2) What are the causes of failure of revision THA in these patients (ie, what are the

indications for repeat revision)? (3) What are the most common complications after revisions of MOM THAs?

Methods We identified 37 patients (24 women, 13 men; mean age, 55 years; 37 hips) revised for aseptic failure of primary stemmed MOM THAs. Reasons for revision included pain with loose components ($n = 19$), adverse reaction to metal debris ($n = 8$), periprosthetic fracture ($n = 4$), impingement ($n = 3$), dislocation ($n = 2$), and pain of unknown origin ($n = 1$). Minimum followup was 24 months (mean, 33 months; range, 24–81 months) postrevision, but 11 were not seen in the last 2 years as our routine followup is at 2 and 5 years. Clinical histories were reviewed for reasons for failure of the MOM THAs and complications associated with revision surgery.

Results Survivorship free from further revision for any cause was 95% at 24 months and 92% at latest followup (24–81 months). There were three repeat revisions, all for periprosthetic infection, and all were treated with two-stage reimplantation. No other complications were observed.

Conclusions We observed a higher-than-expected rate of infection after revision of MOM THAs. The infection rate was higher in this report than in an earlier series looking at revision THAs for other indications at our institution. As revision of MOM THA becomes more common, it will be important to continue monitoring postrevision outcomes and providing treatment strategies to mitigate complications for these patients.

Level of Evidence Level IV, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

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Introduction

Metal-on-metal (MOM) THAs have been performed in selected patients over the past 15 years, based on the

theoretical advantage of improved wear and the ability to use large-diameter femoral head components to minimize dislocation [23]. Despite these potential benefits, many MOM implants have not fared as well as other bearings [2, 8, 9, 17, 25, 27]. Adverse reaction to metal debris (ARMD) from either aseptic lymphocytic vasculitis-associated lesions (ALVALs) or metallosis can precipitate implant failure, in addition to more universal problems, including infection, dislocation, fracture, and component wear [1, 3–5, 7, 11–13, 24, 26]. An increasing body of evidence suggests that these implants have higher rates of complications and failure than ceramic or polyethylene alternatives [9, 15, 25]. As such, revision of MOM arthroplasty has become increasingly common.

Currently, few studies demonstrate how these patients fare after their revision surgery [18, 24]. In this study, we posed the following questions: (1) What is the short-term survivorship of revision THA in patients whose index THAs employed an MOM bearing? (2) What are the causes of failure of revision THA (that is, what are the indications for repeat revisions, when they occur) in these patients? And (3) what are the most common complications after revisions of MOM THAs?

Patients and Methods

After obtaining institutional review board approval, we reviewed all patients undergoing revision hip arthroplasty at our institution between January 2005 and May 2010. We identified 58 patients who had revision of a primary MOM THA. Revisions from hip resurfacing and septic revisions were excluded, leaving 37 patients (37 hips) for review. Twenty-four patients were women and 13 were men, with an average age of 55 years (range, 29–76 years) at the time of their primary MOM implant surgery. The time between index MOM THA and revision was available in 34 patients and averaged 27 months (range, 0.75–110 months). All of the revisions were performed for aseptic modalities of failure. The reasons for revision (diagnosed as described below) included pain with loose components ($n = 19$, 51%), ARMD ($n = 8$, 22%), periprosthetic fracture ($n = 4$, 11%), impingement ($n = 3$, 8%), dislocation ($n = 2$, 5%), and pain of unknown origin ($n = 1$, 3%). Patients were followed for a minimum of 24 months (mean, 33 months; range, 24–81 months) postrevision. Eleven of the 37 patients have not been seen at our institution within the past 24 months as our routine joint arthroplasty followup is at 2 and 5 years postoperatively.

Our study cohort included only aseptic revision cases after review of preoperative and postoperative infection parameters. The indications for revision surgery were determined to be aseptic by the operating surgeon and medical team through

a combination of physical examination, radiographs, and laboratory studies. Furthermore, all cases had negative microbiology cultures from intraoperative tissue specimens and/or synovial fluid aspirates, which we use as our gold standard in the diagnosis of infection.

At the time of revision, the previous surgical approach was utilized when possible. A thorough débridement of soft tissue and cystic masses was done, with special attention at removing necrotic tissue wherever present. The implants were revised; however, the femoral stem was commonly not revised and translated into an anterior or posterior soft tissue pocket to allow exposure of the acetabulum. The acetabular component was removed with an explant device. Reaming was carried out to achieve bleeding bone within a hemispherical cavity. Implantation of a press-fit uncemented hemispherical component was performed and supplemented with screw fixation. A highly crosslinked polyethylene liner was employed in addition to a ceramic head if possible. Ceramic heads with a titanium sleeve were utilized on a used trunnion, that is, if the stem was not revised. A 36- or 40-mm head was used most commonly, but the goal was to enhance stability by using a larger femoral head size when possible.

Radiographic parameters were assessed in all patients preoperatively and at last followup (Table 1). Pre- and post-revision complications were defined as follows. Pain with loose components applied to all patients with components displaying positional change, complete radiolucent lines about the implant, or that were found to be grossly loose intraoperatively. Infection was defined as a positive intraoperative tissue culture. ARMD was determined by pathologic findings of ALVALs or with the presence of a pseudotumor with well-fixed implants. Fracture was the primary diagnosis for patients with evidence of fracture on radiograph and intraoperatively. Dislocation was applied to patients with a history of recurrent dislocation and instability as the primary reason for revision. Impingement was the categorization for patients who experienced pain or limited ROM consistent with prosthetic-bone impingement on physical examination, radiographs, and intraoperative findings. Pain of unknown origin was used for one patient who had pain in the absence of any identifiable cause listed above.

A Kaplan-Meier curve was generated to analyze post-revision survivorship. All analyses were performed using SAS® Version 9.2 (SAS Institute, Inc, Cary, NC, USA) and R Version 2.14 (R Development Core Team, Vienna, Austria).

Results

Survivorship free from further revision for any cause was 95% at 24 months and 92% at most recent clinical

Table 1. Summary data of revision MOM THAs

Patient	Age (years)	Sex	Presenting symptoms	Reason for revision	Implant type*	Symptom onset	Abduction angle (°)	Head size (mm)	ESR (mm/hour)/CRP (mg/L)	Time to revision (months)	Intraoperative findings	Revision type	Complications
1	47	Male	Chronic groin pain with 8 dislocations	Dislocation	Biomet	Since revision	49	NA	9/0.3	110	Fascial defect with clear fluid collection; abductors obliterated	Cemented cup with POM bearing	Infection requiring 2-stage reimplantation
2	48	Male	Pain	Atraumatic periprosthetic fracture	NA	1 year postop	NA	NA	NA/3.8	12	Partial avulsion of the anterior abductors; hematoma	Original cup and extensive porous-coated femoral stem with MOM surface	None
3	49	Female	2 dislocations	Loose components	NA	4 years postop	75	38	16/0.3	48	Fibrous tissue	Complex revision with tantalum; POM	None
4	36	Male	Groin pain	Periprosthetic fracture	NA	NA	30	NA	25/0.5	78	Abductors deficient; greater trochanter nonunited; pelvic discontinuity	Shell and stem replacement with POM	None
5	63	Female	Hip pain	Component loosening	Wright	1 year postop	53	46	14/1.2	6	Metallosis with clear fluid	Uncemented cup with POM surface	None
6	45	Male	Hip pain	Periprosthetic fracture	Biomet	Since first revision	48	38	96/0.9	0.75	Seroma suprafascial; femoral defect posterolaterally	Long modular-tapered link stem; POM surface; hemicondylar strut graft	None
7	76	Male	Hip pain	Component loosening	Biomet	NA	35	38	4/0.1	14	Fibrous membrane posterior to the cup with metallosis	Revision of shell with poly liner on new metal head	None
8	49	Female	Thigh, groin, and buttock pain	Component loosening	Biomet	NA	50	38	4/0.3	20	Fibrous ingrowth of cup	Revision of shell with poly liner on new metal head	None
9	58	Male	Posterior thigh pain	Component loosening	Biomet	Since surgery	64	NA	33/0.6	6	Fibrous ingrowth of acetabulum	Revision of shell, liner, and head to POM	None
10	38	Male	Thigh and groin pain	Component loosening	Biomet	25 months postop	49	38	5/0.6	49	Extensive fibrosis and membrane formation; no visible wear; no seroma or fluid	Femoral stem and head revision; MOM surface	None
11	53	Male	Hip pain and fever	ARMD	NA	Since surgery	35	NA	34/12.6	42	Chronic inflammation with ALVALs; milky fluid in wound	Liner, head, and trunion; POM surface	None

Table 1. continued

Patient	Age (years)	Sex	Presenting symptoms	Reason for revision	Implant type*	Symptom onset	Abduction angle (°)	Head size (mm)	ESR (mm/hour)/CRP (mg/L)	Time to revision (months)	Intraoperative findings	Revision type	Complications
12	54	Female	Groin, buttock, and lateral hip pain	Component loosening	Biomet	Since surgery	41	NA	8/0.3	40	Unhealed capsulotomy; no cup ingrowth	Cup, liner, and head; POM surface	None
13	62	Female	Groin pain	Component loosening	DePuy S-ROM®	Since surgery	36	38	3/0.5	18	Fibrous ongrowth with no signs of infection or fluid collection	Revision of loose acetabular component; exchange of modular head	None
14	63	Female	Thigh, groin, and lateral hip pain	Component loosening	Biomet	Since surgery	68	NA	8/< 3.0	26	Fibrous ongrowth	Shell, liner, head, neck, and stem; POM surface	None
15	62	Female	Groin pain	ARMD	DePuy S-ROM®	Since surgery	36	NA	19/0.3	15	Benign-appearing fluid; ALVALs and chronic inflammation	Shell, liner, and head; POM surface	None
16	54	Male	Groin pain with audible noises	ARMD	DePuy	1 month postop	35	55	46/53	7	Necrosis; metallosis; anterior abductors and vastus lateralis absent	Liner and head; POM surface	Infection requiring 2-stage reimplantation
17	42	Female	Pain	ARMD	Wright	NA	60	NA	6/3.1	NA	Hypervascularity with impingement against the edge of the femoral head	Liner, head, and neck	Infection requiring 2-stage reimplantation
18	56	Female	Posterior dislocation	Dislocation	DePuy	1 month postop	34	NA	5.0/3.0	6	Abductors absent	Head, neck, and liner; POM surface	None
19	63	Female	Groin pain	Impingement	NA	Since surgery	52	NA	15/3.0	14	Psoas tendon frayed; 50% of psoas released intraoperatively	Liner, head, and neck	None
20	63	Female	Hip pain and inability to walk	Component loosening	Biomet	1 year postop	150	36	8/3.0	40	Metallosis with neocapsule; loose acetabulum	Shell, liner, head and tantalum	None
21	73	Male	Hip pain and inability to walk	Periprosthetic fracture	NA	10 years postop	43	NA	5/3.0	3	Solid cup; Vancouver B2	Link head, cable, shell, poly liner, and link collar	None
22	61	Male	History of multiple revisions; hip pain and limp	Component loosening	Zimmer	NA	86	NA	23/3.2	14	Loose acetabular cup	Shell, poly liner, and head	None
23	58	Female	Groin pain with dislocations	Component loosening	Biomet	Since surgery	46	NA	7/3.0	27	Large bluish-gray, cloudy, creamy-colored fluid collection	Shell, poly liner, and head	None

Table 1. continued

Patient	Age (years)	Sex	Presenting symptoms	Reason for revision	Implant type*	Symptom onset	Abduction angle (°)	Head size (mm)	ESR (mm/hour)/CRP (mg/L)	Time to revision (months)	Intraoperative findings	Revision type	Complications
24	61	Female	Groin pain	ARMD	NA	Since surgery	40	NA	37/2.6	19	Cloudy intracapsular fluid; granulation tissue; mild ALVALs	Poly liner and head	None
25	29	Female	Hip pain	Component loosening	Wright	6 months postop	46	40	6/5.3	5	Acetabular osteolysis	Shell, poly liner, neck, and head	None
26	54	Female	Hip pain with audible clunk	ARMD	DePuy	N/A	61	39	3/3.4	24	Proximal femur osteolysis; ALVALs	Shell, poly liner, and head	None
27	57	Female	Thigh pain	Component loosening	NA	Since surgery	48	NA	15/3.0	43	Loose femoral component	Shell, poly liner, femur, and head	None
28	51	Female	Hip pain	Component loosening	Biomet	Since Surgery	20	38	15/3.0	27	Loose acetabular cup	Shell, poly liner, and head	None
29	41	Male	Hip pain	Component loosening	Biomet	2 months postop	69	38	5/5.9	42	Osteolysis of acetabulum; fibrous tissue	Shell, poly liner, and head	None
30	55	Female	Hip pain with audible clunk	ARMD	NA	Since surgery	37	NA	NA	45	Cloudy fluid; fibrous tissue	Shell, poly liner, and head	None
31	48	Male	Hip pain	Component loosening	Zimmer® Durom®	NA	43	NA	4/3.0	NA	Loose cup	Shell, poly liner, and head	None
32	65	Female	Hip pain	Component loosening	Biomet	Since surgery	57	44	6/3.0	36	Loose cup; metallosis	Shell, poly liner, and head	None
33	76	Female	Hip pain	Component loosening	NA	NA	130	NA	10/3.0	NA	Milky fluid; loose cup	Shell, poly liner, and head	None
34	64	Female	Groin pain	Impingement	DePuy	7 months postop	45	46	15/42.4	11	Thick capsule	Shell, poly liner, and head	None
35	68	Female	Groin pain	ARMD	Biomet	6 months postop	30	NA	53/40.9	5	Fibrous tissue with chronic ALVALs	Shell, poly liner, and head	None
36	51	Female	Groin and buttock pain	Pain	Biomet	Since surgery	63	48	17/3.6	37	Fibrous tissue; yellow fluid; focal ALVALs	Shell, poly liner, and head	None
37	50	Female	Noise and catching	Impingement	DePuy Pinnacle®	2 months postop	45	36	5/3.0	14	Gray fluid; metallosis; impingement	Shell, poly liner, and head	None

* Implant manufacturers included Biomet Inc (Warsaw, IN, USA), Wright Technology Inc (Arlington, TN, USA), DePuy Orthopaedics Inc (Warsaw, IN, USA), and Zimmer Inc (Warsaw, IN, USA); MOM = metal on metal; ARMD = adverse reaction to metal debris; NA = not available; postop = postoperatively; ESR = erythrocyte sedimentation rate; CRP = C-reactive protein; ALVAL = aseptic lymphocytic vasculitis-associated lesion; poly = polyethylene; POM = polyethylene on metal.

Fig. 1 A Kaplan-Meier curve shows that survivorship free from further revision for any cause was 95% at 24 months and 92% at most recent followup.

followup, which ranged from 24 to 81 months postrevision depending on the patient (Fig. 1). At latest followup, three hips (8.1%) required a reoperation for infection. The three patients who developed infection after the index revision had initially been revised for ARMD ($n = 2$) and dislocation ($n = 1$). Intraoperative cultures were positive for coagulase-negative *Staphylococcus* in two and Group G *Streptococcus* in one. Apart from the repeat revisions for infection, no other postrevision complications were observed in this patient cohort.

Discussion

Many recent studies have demonstrated that some MOM THAs have inferior implant survivorship in comparison to other bearing surfaces [9, 15, 25]. In light of the early failure of many MOM implants, more practices are seeing patients who meet indications for revision surgery for failures related to this bearing surface, but there are few reports on survivorship and causes of failure after revision of MOM THAs [18, 24]. We therefore reported our experience from one institution and answered the following questions: (1) What is the short-term survivorship of revision THA in patients whose index THAs employed an MOM bearing? (2) What are the causes of failure of revision THA (that is, what are the indications for repeat revisions, when they occur) in these patients? And (3) what are the most common complications after revisions of MOM THAs?

This study is limited in some critical areas. First, our relatively small sample size does not allow for statistically significant conclusions to be drawn, in addition to limiting generalizability. When considered in combination with the short-term followup, it is important to realize that perhaps a greater variety of postrevision complications could be

observed with a larger patient cohort and extended followup period. However, despite the small sample size, the risk of infection was surprisingly high, and we therefore felt compelled to report on it. Second, our study did not include a contemporaneous control group or a statistically valid matched historical control group. We do note, though, that compared to an earlier published series (including patients from 1969 to 1996) that did not include MOM THAs [6], the frequency of infection in the present series appears high. It is also possible that ARMD was underreported in this series as we only included those with ALVALs from histology or frank intraoperative pseudotumors or metallosis.

The survivorship of our patients was 95% at 2 years and 92% at most recent clinical followup (24–81 months). These rates are concerning particularly when considering the short-term followup in this cohort. Importantly, 11 of the 37 patients have not been seen at our institution in the past 24 months, and given that they could have been revised elsewhere during this time period, the concerning survivorship data in this series only represent a best-case scenario.

The singular cause of repeat revision observed in our study cohort at this early followup period was infection, at 8.1% (three of 37 patients). This is much higher than what we have seen over sustained periods of time at our institution. In a publication by Hanssen and Rand [6], 3.2% of 7161 revision THAs performed between 1969 and 1996 at our institution were complicated by infection. This represents a time period before MOM was performed and thus serves as an internal control to compare infection rates with the current study. With a larger sample size and longer-term followup, we hope to determine whether this apparent finding indeed is valid. Nevertheless, the rate of infection at this time point is concerning and demands current attention and further investigation.

Beyond the three patients who were rerevised for a failure due to infection, no other postrevision complications were observed in this series. The complication profile observed at our center differs from the findings of a smaller series of 32 patients reported on by Munro et al. [18] in which they observed major complications in 38% of patients where dislocation was prominent at 28%. Dislocation is certainly a concern in patients being revised from an index MOM implant as it often necessitates downsizing the femoral head component. The risk of this complication can be further amplified in cases where ARMD or infection leads to significant soft tissue damage in failure of the primary implant. This was mitigated in our series as we only selected aseptic failures and was amplified in the study by Munro et al. [18] as their study cohort involved many patients being revised for a pseudotumor. It is however common practice at our institution to use larger head sizes to prevent postoperative dislocation.

While still being susceptible to complications universal to all hip arthroplasties, MOM implants also pose the challenge of ARMD. The exact molecular and cellular mechanisms of ARMD are complex and poorly understood, but some authors have suggested the primary etiology is a delayed Type IV hypersensitivity reaction to metal debris [16, 19–21]. What is clear is that ARMD has a broad spectrum of clinical presentations that can be difficult to differentiate from other modalities of hip pain. Complications can include soft tissue damage, osteolysis, pseudotumor formation, fluid collections or cysts, and vascular pathology. In addition, it has been shown to mask or be present in conjunction with infection [10, 14]. Although we cannot establish a cause-and-effect relationship in our study, it is interesting to note that two of the three postrevision infection complications were in hips initially revised for ARMD. Perhaps this aggressive inflammatory process is locally predisposing to a greater infection risk through immune system modification, remaining particulate debris, or bacterial seeding of damaged tissue. This observation is not unprecedented, as Petrie et al. [22] found that patients with metal-backed patella components in TKA were at an increased risk of postoperative infection.

Patients who present with a failed MOM THA may be at higher risk for infection when they undergo revision THA. The experience from this series should raise the index of suspicion for surgeons in equivocal cases of infection after revision of a MOM THA. As revision of primary MOM THA becomes more commonplace, it will be important to continue monitoring the postrevision outcomes of these patients and providing treatment options to mitigate complications with their revision implants.

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