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Revision of failed metal-on-metal total hip arthroplasty using cemented arthroplasty: a mean 10-year follow-up of 157 consecutive patients

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Abstract

Objective: This study was performed to assess the outcomes of Asian patients who underwent conversion from metal-on-metal total hip arthroplasty (MoM-THA) to cemented THA (CTHA).
Methods: One hundred and fifty-seven consecutive patients (157 hips) who underwent CTHA following primary MoM-THA from January 2005 to February 2015 were retrospectively analysed. The primary endpoints were the clinical outcomes. Follow-ups occurred at 3 months, 6 months, 1 year, 2 years, and then every 2 years following revision of MoM-THA.
Results: The mean follow-up after conversion was 10 years (range, 5–14 years). Statistically significant improvements in the mean Harris hip score were observed between the preoperative and final follow-up evaluations (62.71 ± 13.85 vs. 84.03 ± 16.21, respectively). The major orthopaedic complication rate was 16.5% (26/157). Six (3.8%) patients underwent revision at a mean of 3.5 ± 1.3 years after conversion, predominantly because of prosthesis loosening or recurrent dislocation. Nine (5.7%) patients developed prosthesis loosening at a mean of 2.6 ± 1.1 years following conversion, two of whom requested revision surgery. Eleven (7.0%) patients developed prosthesis dislocation, four of whom requested revision surgery.

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Conclusion: CTHA may yield favourable functional outcomes and a reduced rate of major orthopaedic complications.

Keywords
Conversion, revision, metal-on-metal, outcome, complication, total hip arthroplasty

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Introduction

Orthopaedic-related complications induced by metal-on-metal total hip arthroplasty (MoM-THA) have become a growing concern.[1,2] In the last 10 years, surgeons have commonly performed cemented THA (CTHA) revisions to manage such challenging complications in the elderly population.[1,3] However, because CTHA is so frequently performed, the potential complications of MoM-THA have been studied by many authors.[4,5] Revision following MoM-THA is a well-documented procedure, especially in patients with osteoporosis,[5] which is an extremely critical condition. However, no effective coping strategies have been developed with the exception of prosthetic revision.[6,7] The occurrence of severe complications after MoM-THA associated with adverse reactions to metal debris (ARMD) are common and may be related to osteolysis and patient activity.[8–10] When damage to the bone and surrounding tissues is caused by MoM-THA, patients who undergo revision MoM-THA may develop secondary damage to the joints, and a high rate of postoperative complications is expected.[10,11] However, the reported short- and mid-term clinical outcomes following MoM-THA are inconsistent,[3,4] and studies[5,12] on the long-term clinical outcomes are lacking.

To explore the clinical outcomes of primary MoM-THA converted to CTHA, we performed a review to evaluate the 10-year clinical outcomes of Asian patients undergoing this conversion.

Materials and methods

Study population

This review was approved in March 2015 by the Institutional Review Board (IRB) of The First Affiliated Hospital of Fujian Medical University. The requirement for informed consent was waived by the IRB, and the identity of the patients cannot be ascertained in any way. All patients provided consent for treatment.

Consecutive patients who underwent CTHA following initial MoM-THA failure in our Joint Surgery Center from January 2005 to February 2015 were identified and retrospectively analysed. The indications for conversion were ARMD, recurrent dislocation, aseptic loosening, and periprosthetic fracture. The inclusion criterion was conversion of primary MoM-THA (Zimmer Biomet, Warsaw, IN, USA) to CTHA (Exeter stem and Elite cup; Stryker, Kalamazoo, MI. USA) by three high-volume reconstructive surgeons (J.L., X.Z., and G.H.). The exclusion criteria were incomplete follow-up data, hip dysplasia prior to revision, an inability to comply with follow-up arrangements, disorders of bone metabolism, blood-related diseases (e.g., aplastic anaemia), cancer, multiple injuries prior to revision, severe medical diseases (e.g., uraemia, active infectious disease, or stroke), and mental disorders.

Standardised management procedures were implemented for each patient. Surgery details and patient management after revision were determined based on

our previous study.[3] Follow-ups occurred at 3 months, 6 months, 1 year, 2 years, and then every 2 years following revision MoM-THA. The primary endpoints were the clinical outcomes, including the functional outcomes assessed using the Harris hip score (HHS) and the radiographic outcomes. Data on the clinical outcomes were gathered by two authors (J.L. and G.H.). We did not exclude the HHS evaluation in patients with implant failure.

Statistical analysis

Revision was defined as a procedure in which the stem and/or cup of the prosthesis was replaced.[4] Categorical data were compared using the chi-square test. Continuous data were compared using Student's t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). A two-sided P value of <0.05 was considered statistically significant.

Results

In total, 226 consecutive patients were initially identified. After application of the exclusion criteria, a cohort of 157 patients (157 hips) who were treated by CTHA following MoM-THA and underwent clinical and radiographic evaluations were included in the study (Figure 1). The average age at the time of conversion was 68.47 years (range, 61–75 years). The average duration between MoM-THA failure and CTHA was 3.7 years (range, 1–6 years). The average follow-up after conversion was 10 years (range, 5–14 years). The mean body mass index, bone mineral density, and preoperative HHS were 27.69 ± 6.28 kg/m^2, -3.62 ± 0.33, and 57.71 ± 13.85, respectively. No patients underwent bilateral conversion. The patients' characteristics are presented in Table 1.

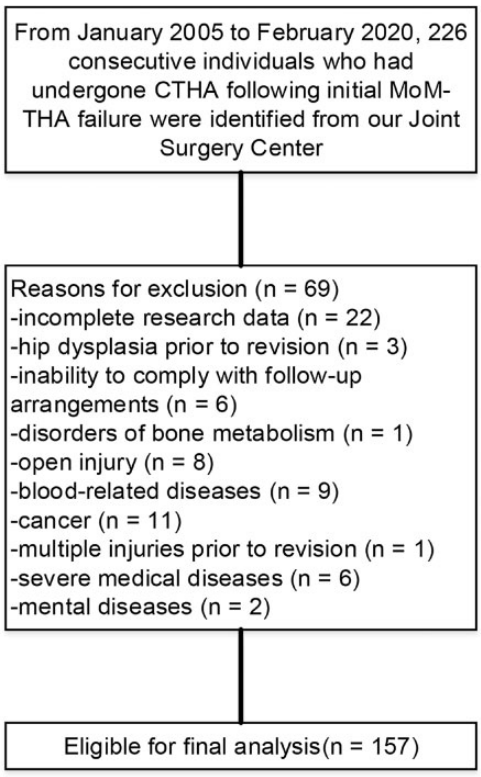

Figure 1. Patient flow diagram.
MoM-THA, metal-on-metal total hip arthroplasty; CTHA, cemented total hip arthroplasty.

Functional outcomes

Table 2 shows the mean HHS after revision. Significant improvements in the mean HHS were observed between the preoperative and final follow-up evaluations (62.71 ± 13.85 vs. 84.03 ± 16.21, respectively; $P < 0.001$). The HHS peaked at 4 years after revision (91.58 ± 8.47). The mean HHS exhibited a decreasing trend from the fourth year postoperatively until the final follow-up.

Radiological outcomes

Table 3 shows the incidence of major orthopaedic complications. At the final

Table 1. Demographics and outcomes in patients who underwent CTHA (n = 157).

Variable	
Sex, male/female	82/75
Age, years	68.47 ± 7.35
BMI, kg/m^2	27.69 ± 6.28
BMD	−3.62 ± 0.33
Side, left/right	69/88
Interval from failure to revision CTHA, years	3.7 (1–6)
Comorbidities	
Hypertension	55 (35.0)
Diabetes mellitus	36 (22.9)
Hypertension and diabetes mellitus	25 (15.9)
Mechanism of injury	
Traffic-related injury	26 (16.5)
Injury by falling	75 (47.7)
Tamp injury	40 (25.4)
Other	16 (10.1)
ASA physical status	
I	38 (24.2)
II	77 (49.0)
III	42 (26.7)
Preoperative HHS	62.71 ± 13.85
Follow-up time (years)	10.51 ± 5.62

Data are presented as n, n (%), mean ± standard deviation, or average (range).
CTHA, cemented total hip arthroplasty; BMI, body mass index; BMD, bone mineral density; American Society of Anesthesiologists; HHS, Harris hip score.

follow-up, 26 major orthopaedic complications were recorded among all 157 patients. The major orthopaedic complication rate was 16.5%, regardless of whether revision was needed (the outcomes of other complications included revision). Six (3.8%) patients underwent revision at a mean of 6.02 ± 2.18 years after conversion, predominantly because of prosthesis loosening or recurrent dislocation. Nine (5.7%) patients developed prosthesis loosening at a mean of 2.6 ± 1.1 years following conversion, two of whom requested revision surgery. Eleven (7.0%) patients developed prosthesis dislocation, four of whom requested revision

Table 2. Long-term follow-up: functional outcomes in patients who underwent CTHA (n = 157).

Months after revision	HHS
3	80.82 ± 10.53*
6	87.46 ± 7.28
12	88.16 ± 7.92
24	89.92 ± 8.64$^{\$}$
48	91.58 ± 8.47$^{\$\&}$
72	89.85 ± 11.36$^{\&\#}$
96	88.42 ± 10.71$^{\#}$
120	86.24 ± 14.04
Final follow-up	84.03 ± 16.21*

Data are presented as mean ± standard deviation.
*$\$\&\#$Statistically significant values.
CTHA, cemented total hip arthroplasty; HHS, Harris hip score.

Table 3. Long-term follow-up: prosthesis-related complications in patients who underwent CTHA (n = 26).

Variable	
Age, years	71.27 ± 3.36
Sex	
Male	11 (7.0)
Female	15 (9.6)
Reason for revision*	
Aseptic loosening	3 (1.9)
Dislocation	3 (1.9)
Interval from revision procedure to failure, years	6.02 ± 2.18
Deep infection**	2 (1.2)
Unbearable hip pain***	4 (2.5)
Aseptic loosening	9 (5.7)
Dislocation	11 (7.0)

Data are presented as mean ± standard deviation or n (%).
*Three patients with aseptic loosening underwent revision using cemented long stems with promising results. Three patients with recurrent dislocations underwent revision using dual-mobility cups (n = 2) and a femoral head diameter of >28 mm (n = 1) with favourable results.
**Debridement surgery.
***Use of functional brace.
CTHA, cemented total hip arthroplasty.

surgery. Four (2.5%) patients had unbearable hip pain, which was relieved with a functional brace. Two (1.3%) patients developed a deep infection and underwent debridement surgery.

Discussion

Our results indicate that conversion of the initial MoM-THA to CTHA may lead to favourable clinical outcomes, including an excellent HHS and few orthopaedic complications. Compared with the clinical outcomes following conversion of MoM-THA to CTHA reported in previous studies,[2,13] our findings are acceptable.

A series of disadvantages attributed to MoM cups have been frequently mentioned in previous studies.[2,6,8,14] These disadvantages have undeniably become key factors limiting the effect of revision.[7,15] Metal ions released by MoM cups affect the activity of osteoblasts at the gene level, which can make CTHA challenging to perform.[1,10–12,16] Previous studies have validated that the complications of conversion from MoM-THA to CTHA are typical of these surgeries and primarily include revision, dislocation, and prosthesis loosening.[6,8] Lainiala et al.[1] reviewed 2520 patients who underwent MoM-THA and found that the most common reason for revision MoM-THA (63%) was failure to tolerate accumulating metal ions. The authors also reported a declining revision burden of MoM-THA.[1] Jennings et al.[2] performed a retrospective review of 53 patients who underwent 54 linear exchange revisions of modular MoM-THA and found a high risk of post-revision complications associated with revising the acetabular component in patients who underwent modular MoM-THA. Crawford et al.[3] examined the mid-term outcomes of revision after failed MoM-THA in 203 consecutive patients and reported complications including soft tissue damage and pseudo-tumours, although the post-revision levels of metal ions substantially declined. The authors also found that the revision rate was drastically higher in patients with soft tissue damage and pseudo-tumours.[3] Borton et al.[4] reviewed a single-centre consecutive series of 180 revisions after MoM-THA and found that the need for revision after failed MoM-THA was a prognostic indicator of poor functional outcomes.

MoM-THA is rarely performed as the primary treatment for hip arthroplasty[2,16] because it is associated with an excessively high incidence of complications.[16] Many patients who have undergone MoM-THA require conversion surgery, although this number of patients gradually decreases each year.[3,7] In addition, the timing of revision MoM-THA and the optimal type of prosthesis have been debated.[10,11] Hip instability due to MoM wear induced by edge loading is associated with poor bone strength.[16] When revision surgery is performed again, bone-related factors can pose a large challenge for surgeons.[11,16] The current tendency is to choose cemented prostheses to overcome this challenge.[7] Among existing studies, CTHA is frequently performed for revision MoM-THA.[17,18] Currently, the risks associated with such revision remain controversial.[19,20] This is inconsistent with our findings and may be explained by the exclusion of a large number of active cases and the high rate of loss to follow-up.[5]

MoM-THA revision for ARMD increases the risk of early to mid-term complications and poor functional outcomes.[11,16] The high percentage of CTHA revision following MoM-THA with a large-diameter head is becoming increasingly recognised.[1,2,21,22] Evidently, the timing of revision CTHA is correlated with that of

ARMD, which is reflected in our results. In other words, a longer duration before performance of MoM-THA is associated with a higher rate of revision CTHA.[5] Rahman et al.[23] reported that 19 of 20 patients underwent MoM-THA conversion to CTHA after an average follow-up duration of 45 months and that the revision rate was 2.2% (1 case of recurrent dislocation that required conversion to a constrained acetabular liner). Penrose et al.[24] reviewed 451 patients who underwent isolated acetabular revision using a MoM bearing and reported a high revision rate of 4.7%.

Several limitations of this study should be recognised. First, this was a retrospective review with inherent limitations. Second, there were no controls in this study. Therefore, the baseline data contain a certain amount of bias. Third, the follow-up duration was relatively long, which can lead to increased values in the follow-up results. Finally, the level of metal ions was not analysed as a variable in this study. Despite these limitations, we used strict inclusion and exclusion criteria, which included certain procedures for the inclusion of patients. In addition, our follow-up results were relatively simple and mainly involved functional and imaging assessments, which could eliminate potential deviations.

Conclusion

The long-term results in this study may support the increasing body of evidence showing that conversion of MoM-THA to CTHA yields favourable functional outcomes and acceptable major orthopaedic complication rates. Additional studies of minimum-risk solutions for these complications (e.g., dislocation and revision) need to be conducted. Based on our previous successful experience, we now perform CTHA (high-ceramic cup with screws) plus intraoperative implantation of autologous bone to treat osteolysis. The problem of failure induced by cup wear also needs to be further explored.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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