Long-term outcomes of uncemented or cemented arthroplasty revision following metal-on-metal total hip arthroplasty failure: A retrospective observational study with a mean follow-up of 7 years

Wenli Chen

Sun Yat-sen University First Affiliated Hospital

Mao Shuai

Sun Yat-sen University First Affiliated Hospital

Jinluan Lin

The Affiliated hospital of Fujian Medical University

Baomin Chen

Sun Yat-sen University First Affiliated Hospital

Mingdong Zhao (✉ zhaonissann@163.com)

Jinshan Hospital, Fudan University

Xinchao Zhang

Jinshan Hospital, Fudan University

Weiguang Yu

Sun Yat-sen University First Affiliated Hospital

Guowei Han

Sun Yat-sen University First Affiliated Hospital

Research article

Keywords: Uncemented, Cemented, Total hip arthroplasty, Metal-on-Metal, Complication

Posted Date: March 17th, 2020

DOI: <https://doi.org/10.21203/rs.2.20209/v3>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: A high rate of metal-on-metal total hip arthroplasty (MoM-THA) has been well-known. The aim of this study was to compare the long-term outcomes of patients who had undergone uncemented or cemented THA(UTHA or CTHA) following initial MoM-THA failure.

Methods: Data from 234 patients (234 hips) who were treated with UTHA or CTHA following initial MoM-THA failure during 2007 - 2018 were retrospectively compared. Follow-up occurred 3 months, 6 months, 1 year, 2 years, and then every 1 year after conversion. The mean follow-up was 84.15 months (67 - 101 months). The primary endpoint was the Harris Hip Scores (HHS); secondary endpoint was the incidence of major orthopaedic complications.

Results: The HHS demonstrated statistically greater differences in Group CTHA than in Group UTHA 12 months after conversion. From the 12th month after conversion to the final follow-up, CTHA yielded superior functional outcomes than UTHA. Between-group noteworthy differences were observed regarding the rates of re-revision, aseptic loosening, and periprosthetic fracture (10.3% for UTHA vs 2.5% for CTHA, $p = 0.015$; 16.3% for UTHA vs 5.9% for CTHA, $p = 0.011$; and 12.0% for UTHA vs 4.2% for CTHA, $p = 0.045$, respectively).

Conclusion: In the setting of revision following initial MoM-THA failure, we found definite evidence of the superiority of CTHA over UTHA in regard to improving functional outcomes and decreasing the incidence of major orthopaedic complications.

Background

In recent years, the use of metal-on-metal total hip arthroplasty (MoM-THA) has sharply declined due to the reported low 10-year survivorship and high failure rates that are associated with a host of issues (i.e., adverse reactions to metal debris [ARMD])[1-4]. Failure after MoM-THA is well-known[5]. Among predominantly active individuals, failure that occurs secondary to MoM wear tends to be a concern[6]. Although MoM bearings have fallen out of favour as a result, orthopaedists continue to struggle with this issue of revision burden[7]. Poor bone stock may be attributed to the substantial bone and soft tissue destruction caused by ARMD that is powerfully implicated in the pathophysiology of MoM-THA failure, contributing to the substantially high revision rate[8].

This intensified MoM-THA failure rate may also contribute to the increase in the use of UTHA or CTHA[8, 9]. A limited number of studies have assessed complications due to the conversion of MoM-THA to UTHA or CTHA[3]. Interest in CTHA has increased over the last decade, with several reports revealing higher Harris hip scores (HHS) with fewer orthopaedic complications for CTHA than for UTHA, while others have exhibited no noteworthy differences between UTHA and CTHA[5]. Besides, there remain concerns that longer-term outcomes of UTHA could fail to be as robust as those of CTHA regarding reduced revision rates[8, 10]. As well, the highly selected features of the studied cohort are common in the previous reports[11, 12]. Thus, the findings in those studies could fail to be referred to as valid.

To date, no definitive consensus exists regarding the long-term outcomes of conversion from initial MoM-THA to UTHA or CTHA due to any cause[11]. Moreover, given the lack of literature, we performed a retrospective study to assess the long-term outcomes of conversion from primary MoM-THA to UTHA or CTHA.

Methods

Study population

An initial study cohort of 326 patients (326 hips) were identified from our joint registration database who were treated with UTHA or CTHA following prior primary MoM-THA failure between March 2007 and January 2018. The main reasons for revision involved ARMD, aseptic loosening, infection, dislocation, and fracture. The inclusion criteria for the study included patients who underwent a conversion procedure from initial MoM-THA (Zimmer Biomet, Warsaw, IN) to UTHA or CTHA; all conversion procedures were performed by three experienced orthopaedists (WY, XZ, MZ) via a direct anterior approach, as reported[13]. Manufacturer details of stems and cups employed in UTHA or CTHA were presented in Table 1. The main exclusion criteria involved cases without an MoM-bearing surface at the time of conversion; lacking clinical data, severe infectious diseases(i.e., acute inflammatory response syndrome), dyskinesia, or bone-related diseases; unable to follow instructions; tumours, organ dysfunction, and an American Society of Anesthesiologists (ASA) score of IV or V.

Data were collected according to a standard protocol. Follow-up occurred 3 months, 6 months, 1 year, 2 years, and then every 1 year after conversion. The primary endpoint was the HHS; secondary endpoints were the incidence of major orthopaedic complications. Patients included were assessed individually using the HHS at each follow-up. Image data were acquired at these same time points.

Statistical analysis

Revision was defined as the removal of the entire endoprosthesis. Re-revision was defined as the removal or exchange of any component. Prosthesis loosening or failure were assessed according to previous report[8, 14]. For continuous data, T-tests were utilised to assess between-group differences if the data were consistent. If not, Wilcoxon rank-sum tests were done. Categorical data were compared between groups using Chi-squared tests or Fisher's exact tests, as appropriate. All statistical analyses were done using SPSS 24.0 (IBM, Armonk, NY). A 2-sided *p* value less than 0.05 was considered significant.

Results

A total of 234 individuals (234 hips) undergoing conversion from initial MoM-THA to UTHA or CTHA were identified for the final analysis (UTHA: *n* = 116, mean age, 67.34±6.25 years; CTHA: *n* = 118, mean age, 67.45±6.21 years). The mean time to failure after initial MoM-THA was 4.3 years (1.2 - 6.5 years) for UTHA and 4.4 years (1.1 - 6.4 years) for CTHA. At the time of analysis, the mean follow-up from

conversion was 84.12 months (67 - 100 months) for UTHA and 84.23 months (66 - 101 months) for CTHA. A study flow chart was exhibited in Figure 1, and the baseline data were presented in Table 2.

Primary endpoint

The mean HHS after conversion were presented in Table 3. The mean HHS in Group UTHA and CTHA were 79.14 (± 8.12) and 79.28 (± 7.66) 3 months after conversion, 86.65 (± 6.62) and 87.76 (± 7.44) 6 months after conversion, 88.17 (± 7.72) and 91.43 (± 8.52) 12 months after conversion, and 79.18 (± 11.12) and 84.32 (± 10.35) at final follow-up, respectively. The HHS revealed statistically greater differences in Group CTHA than in Group UTHA 12 months after conversion ($p = 0.031$). From the 12th month after conversion to final follow-up, CTHA yielded better functional outcomes than UTHA (all $p < 0.05$). Almost 76% of the cases with MoM-THA failure treated with a conversion to UTHA or CTHA had favourable HHS at final follow-up. Between-group differences in HHS were not significant 3 months or 6 months after conversion.

Secondary endpoint

There were 83 major orthopaedic complications in 116 UTHA cases versus 47 in 118 CTHA cases. Of 83 complications, 12 (10.3%) involved re-revision, 19 (16.3%) were associated with aseptic loosening, 14 (12.0%) involved periprosthetic fractures, and 6 (5.1%) involved unbearable hip pain. Of 47 complications, 3 (2.5%) involved re-revision, 7 (5.9%) were associated with aseptic loosening, 5 (4.2%) involved periprosthetic fractures, and 8 (6.7%) involved intolerable hip pain (Table 4). The between-group difference in the re-revision rate was significant at final follow-up (10.3% for UTHA vs 2.5% for CTHA, $p = 0.015$). Almost 82.1% of the cases of re-revision for UTHAs were attributed to aseptic loosening compared to 73.5% of the cases of re-revisions for CTHAs ($p = 0.034$). The mean time from revision to re-revision was 3 years (1.4 - 3.5 years) for UTHA and 3 years (1.2 - 3.6 years) for CTHA ($p = 0.154$).

Discussion

Our findings provide evidence that the revision of initial MoM-THA failure using CTHA yielded superior long-term clinical outcomes compared to the use of UTHA. To our knowledge, this is the largest study regarding outcomes due to conversion after MoM-THA failure.

Complications of MoM-THA related to ARMD could result in noteworthy bone and soft tissue destruction as well as increased metal ion levels, potentially increasing the risk of endoprosthesis failure[8, 5]. These ions can downregulate osteoblast gene expression and have a negative impact on osteoblast cell number and activity, which could ultimately lead to bone ingrowth failure in the uncemented components[3, 7, 14]. The results of MoM-THA revision have revealed high rates of orthopaedic complications due to aseptic loosening[3]. In a recent report[15], the 14-year cumulative probability of revision was 22.2% for uncemented MoM-THA; the 15-year cumulative probability of revision was 29.6%. Whether increases in hip stability exist after MoM-THA revision has become one of the key indicators[8, 16, 17]. Hip stability following conversion to CTHA is superior to that following conversion to UTHA owing to the instability of

the bone and uncemented components[8]. Macroscopic damage or bone defects were frequently observed at the time of UTHA [14]. The trigger of bone defects has been reported to be associated with malposition and a flawed design for the acetabular component, resulting in abnormally elevated wear triggered by edge loading[18, 1]. Failure due to aseptic loosening occurs more frequently with UTHA than with CTHA[19].

The risks associated with conversion from MoM-THA to UTHA or CTHA remain a substantial concern[14, 8, 3]. Nonetheless, the obtainable literature on the outcomes of this type of conversion is deficient[20, 4, 21]. Several studies have revealed noteworthy differences in clinical outcomes, although these studies are limited by small sample sizes and/or short-term follow-up[3, 13, 8]. Undeniably, invasive revision procedures are associated with a high incidence of orthopaedic complications[8]. However, we failed to detect noteworthy distinctions regarding the incidences of major orthopaedic complications 12 months after conversion. Concerns have existed regarding whether these two types of conversion have substantial differences in long-term outcomes, including orthopaedic complication incidences[3, 8, 17]. In 2009, Eswaramoorthy et al[23] reported on 76 patients who underwent conversion from MoM-THA to UTHA. Similar to the findings observed in the current study, both aseptic loosening and periprosthetic fracture were the primary orthopaedic complications. They also described a high incidence of major orthopaedic complications (24%), mostly attributable to a high rate of aseptic loosening (20%). Then, Stryker et al.[24] reported on 114 cases of conversion from MoM-THA to CTHA and demonstrated a major orthopaedic complication rate of 18%, with a re-revision rate of 7%, primarily attributable to aseptic loosening (14%) and deep infection (6%).

This present study also reveals that the reason for conversion has a prevailing impact on the outcomes of conversion. With modern THA and surgical techniques, conversion due to an indication of MoM wear has low rates of re-revision, regardless of the use of UTHA or CTHA for conversion, whereas conversion due to conventional periprosthetic fracture tends to be associated with a higher rate of re-revision.

Several limitations should be acknowledged in this study. Firstly, selection bias was inevitable due to the exclusion of a number of cases. Secondly, this retrospective observational study was susceptible to errors in recording differences in comorbidities and orthopaedic complications, which may have produced unaccounted confounding variables and may have led to a diminished power to draw convincing conclusions. Thirdly, we failed to involve metal ion concentrations as well as information about high- and low-volume orthopaedists.

Conclusions

The long-term results reported in this study support a growing body of evidence that conversion to CTHA due to primary MoM-THA failure is associated with more significant improvements in modified HHS as well as lower major orthopaedic complication rates than conversion to UTHA.

Declarations

Acknowledgements

The authors would like to thank Hang Yu and Junxing Ye for help with retrieval of patients’ data.

Funding

Funding for this research was received from the National Natural Science Foundation of China (Grant No. 81971315).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Authors' contributions

WC, SM, JL, and BC performed the data collection and analysis and participated in manuscript writing. MZ, XZ, WY, and GH performed the surgical procedures and participated in the study design and coordination. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the Investigational Ethics Review Board (The First Affiliated Hospital, Sun Yat-sen University), and an exemption from informed consent was obtained from the review board.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

UTHA: uncemented total hip arthroplasty; CTHA: cemented total hip arthroplasty; MoM-THA: metal-on-metal total hip arthroplasty; ARMD: adverse reaction to metal debris; BMD: bone mineral density; ISS: injury severity score; BMI: body mass index; ASA: American Society of Anesthesiologists; HHS: Harris hip scores.

References

Tables

Table 1 Manufacturer details of UTHA and CTHA

Patients, No.	Stem	Cup
UTHA		
65	Corail ¹ ,	Reflection uncemented ² ,
51	Filler ³ ,	Trident ⁴ , Igloo ³ ,
CTHA		
69	Exeter ⁴ ,	Exeter ⁴ , Elite ⁴ , IP/SP1 ⁵ ,
49	Spectron EF ² ,	Contemporary ⁴ , Marathon ¹ ,

¹DePuy, ²Smith & Nephew, ³Biotechni, ⁴Stryker, ⁵Waldemar LINK. UTHA: uncemented total hip arthroplasty; CTHA: cemented total hip arthroplasty.

Table 2 Patient demographics

Variable	UTHA ^a (n=116)	CTHA ^b (n=118)	p-value
Sex, M/F	52/64	53/65	0.409 ^c
Age, (y)	67.34±6.25	67.45±6.21	0.142 ^d
BMI, kg/m ²	28.23±7.32	28.15±7.22	0.261 ^d
BMD	-3.47±0.26	-3.48±0.42	0.132 ^d
Side, L/R	56/60	57/61	0.277 ^c
Interval to failure after initial MoM- THA (y)	4.3(1.2 - 6.5)	4.4(1.1 -6.4)	0.331 ^d
Comorbidities, n%			0.402 ^e
Hypertension	61(52.5)	69(58.4)	
Diabetes mellitus	32(27.5)	28(23.7)	
Hypertension and Diabetes mellitus	23(20.0)	21(17.9)	
Mechanism of injury, n%			0.780 ^e
Traffic	26(22.4)	28(23.7)	
Falling	51(43.9)	46(38.9)	
Tamp	39(33.7)	44(37.4)	
ASA scale, n%			0.920 ^e
I	22(18.9)	24(20.3)	
II	64(55.1)	63(53.3)	
III	30(26.0)	31(26.4)	
Preoperative HHS	56.33±17.36	56.43±16.92	0.164 ^d
Follow-up (mos)	84.12±16.62	84.23±17.49	0.214 ^d

UTHA^a: uncemented total hip arthroplasty; CTHA^b: cemented total hip arthroplasty;

^cAnalysed using the chi-square test; ^dAnalysed using an independent-samples t-test;

^eAnalysed using the Mann-Whitney test. BMI: body mass index; BMD: bone mineral density; MoM-THA: metal-on-metal total hip arthroplasty; ASA: American Society of Anesthesiologists; HHS: Harris hip scores.

Table 3 Long-term follow-up: functional outcomes

HHS, month after conversion	UTHA ^a (n=116)	CTHA ^b (n=118)	p-value
3	79.14±8.12	79.28±7.66	0.212
6	86.65±6.62	87.76±7.44	0.181
12	88.17±7.72	91.43±8.52	0.031*
24	88.72±7.35	90.47±7.75	0.036*
36	87.14±8.43	89.43±8.27	0.027*
48	87.56±9.42	88.77±9.72	0.025*
60	86.32±9.68	87.73±11.25	0.014*
72	82.29±10.16	85.71±10.12	0.011*
84	79.78±11.65	84.72±11.82	<0.001*
Final follow-up	79.18±11.12	84.32±10.35	<0.001*

*Statistically significant values.

UTHA^a: uncemented total hip arthroplasty; CTHA^b: cemented total hip arthroplasty; HHS: Harris hip scores.

Table 4 Long-term follow-up: prosthesis-related complications

Variable, n%	UTHA ^a (n=116)	CTHA ^b (n=118)	p-value
Re-revision	12(10.3)	3(2.5)	0.015*
Aseptic loosening	19(16.3)	7(5.9)	0.011*
Periprosthetic fracture	14(12.0)	5(4.2)	0.045*
Dislocation	10(8.6)	4(3.3)	0.092
Femur shaft fracture	3(2.5)	3(2.5)	0.983
Deep infection	3(2.5)	8(6.7)	0.130
Unbearable hip pain	6(5.1)	8(6.7)	0.604
Lower limb shortening (>1.5 cm)	5(4.3)	2(1.6)	0.240

*Statistically significant values.

UTHA^a: uncemented total hip arthroplasty; CTHA^b: cemented total hip arthroplasty.

Figures

Figure 1

Flow diagram showing methods for identification and exclusion of patients to compare the long-term outcomes of patients who had received an uncemented or cemented total hip arthroplasty (THA) for failed initial metal-on-metal THA (MoM-THA).