

## General

# Complication Rates of Hemiarthroplasty Conversion to Total Hip Arthroplasty Versus Primary Total Hip Arthroplasty

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### Background

One of the most common surgical options for treatment of a femoral neck fracture is hemiarthroplasty (HA). However, progression of arthritis or pain can necessitate conversion to total hip arthroplasty (THA). While conversion to a THA is a viable option, it does carry multiple risks. The purpose of this study was to identify whether performing conversion from HA to THA carries an increased risk of post-operative joint complications when compared to elective THA.

### Methods

An administrative claims database was queried to identify patients who underwent conversion from a HA to a THA. Incidences of prosthetic dislocation, prosthetic joint infection (PJI), periprosthetic fracture, aseptic loosening, and revision were collected and compared to elective primary THA with multivariable logistic regression.

### Results

Patients undergoing conversion THA had significantly higher risks of all joint complications examined at both 1 and 2 years after surgery. These included prosthetic dislocation (1-year: OR 2.95; 2 years: OR 3.77), PJI (1-year: OR 1.38; 2 years: OR 2.13), periprosthetic fracture (1-year: OR 2.95; 2 years: OR 3.75), aseptic loosening (1-year: OR 6.86; 2 years: OR 7.70), and revision (1-year: OR 3.65; 2 years: OR 6.73).

### Conclusion

Performing conversion arthroplasty from HA to THA is associated with an increased risk of multiple joint complications in both the short and mid-term follow-up period. Surgeons should consider these complications when indicating HA for femoral neck fractures and elective conversion arthroplasty.

## INTRODUCTION

Total hip arthroplasty (THA) is a highly successful surgery for the management of hip pathology that yields excellent short-term and long-term outcomes.<sup>1</sup> Of the estimated 370,000 THAs performed annually in the United States, over 90% are performed electively to manage hip osteoarthritis.<sup>2</sup> Total hip arthroplasty is also a viable option for managing femoral neck fractures. However, performing THA for frac-

ture indications carries an increased risk of perioperative and postoperative complications.<sup>3-5</sup> Potential postoperative complications after THA include pain, prosthetic dislocation, fracture, infection, and abductor insufficiency.<sup>6,7</sup>

Hemiarthroplasty (HA) is one of the most common treatments for femoral neck fractures.<sup>8</sup> HA has been shown to yield better results than internal fixation for displaced femoral neck fractures in the elderly as it permits full weight-bearing immediately after surgery without the risk of complications such as avascular necrosis.<sup>9</sup> However, HA

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has been linked to higher reoperation rates and worse functional outcomes compared to THA in community ambulators and active patients.<sup>4,10,11</sup> Common indications for reoperation after HA include aseptic femoral loosening, periprosthetic fractures, and development of acetabular arthritis.<sup>12</sup>

With the development of acetabular arthritis, conversion of HA to THA is commonly performed for pain relief to remove the articular bearing against the metal prosthetic femoral head.<sup>13–15</sup> Compared to primary THA, HA conversion to THA has been associated with higher rates of reoperations and complications.<sup>16–19</sup> Studies demonstrating matched cohorts have involved conversions done for all failed hip fractures, including those receiving cephalomedullary nails, percutaneous screw fixation, and sliding hip screws. However, there is little data comparing large, matched cohorts to evaluate the complication rates to evaluate HA conversion to elective THA. It was hypothesized that HA conversion would be associated with an increased risk of adverse outcomes despite the surgical procedure primarily addressing the acetabulum during a HA conversion.

## METHODS AND MATERIALS

### DATA SOURCE

A retrospective cohort study was designed in which patient records were queried from PearlDiver (PearlDiver Inc. Fort Wayne, IN), a commercially available administrative claims database. This study used data from the “MHip” dataset provided within PearlDiver, which contains approximately 1 million patients from 2010 through Q1 of 2020. Primary and secondary outcomes were defined using International Classification of Disease, Ninth Revision and Tenth Revision (ICD-9 and ICD-10) codes, as well as Current Procedural Terminology (CPT) codes. Institutional Review Board exemption was granted through Tulane University Human Research and Protection Program as the provided data were deidentified and compliant with the Health Insurance Portability and Accountability Act.

### PATIENT SELECTION

Patients aged 65 and older were included. Using CPT codes, patient records were selected and separated into either the “conversion” cohort if they had undergone HA (CPT-27236 and CPT-27125), then conversion of a previous HA to THA with or without allograft (CPT-27132), or a “primary THA” cohort if they had undergone a primary THA (CPT-27130). The code CPT-27236 is for open treatment of femoral neck fracture with internal fixation or prosthesis. Given the specified age to only include patients over 65, the likelihood of capturing failed open reductions with internal fixation in the conversion cohort was minimized. Becket al demonstrated that 34% percent of femoral neck fractures that receive HA are incorrectly coded as CPT-27125, which is for elective HA.<sup>20</sup> Both CPT-27236 and CPT-27125 were included to catch all HA conversions to THA, whether the HA was for a femoral neck fracture or other indications.

Cohorts were then matched based on gender, region, and Charlson Comorbidity Index (CCI), to create similar popu-

lations. To ensure a minimum 2-year follow-up in the database for all included patients in both cohorts, only patients who underwent primary THA or conversion of previous hip surgery between 2010 through the end of 2018 were included. Exclusion criteria for both cohorts included arthroplasty for pathologic fractures or arthroplasty procedures that were miscoded as revision arthroplasty. Patients were also excluded from the conversion cohort if they had undergone closed reduction with percutaneous pinning (CRPP) for a proximal femur fracture. The ICD codes that defined the different cohorts are provided in **Appendix Table A1**.

### OUTCOMES

This study’s primary outcomes included examining prosthetic joint infection rates (PJI), prosthetic joint dislocation, periprosthetic fracture, aseptic loosening, and revisions at both 1 and 2 years post-surgery. PJI was defined by procedural codes that indicated a surgical intervention for a deep joint infection and excluded any superficial complications such as stitch abscesses or wound complications. In addition to looking at joint complication rates, each cohort was queried for basic demographic and clinical information such as sex, BMI, and comorbidities. Comorbidities examined included tobacco use, rheumatoid arthritis, liver disease, congestive heart failure (CHF), coronary artery disease (CAD), ischemic heart disease (IHD), pulmonary heart disease (PHD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), dementia, diabetes mellitus, hypertension, and peripheral vascular disease (PVD).

### STATISTICAL ANALYSIS

All data analyses were performed using the R statistical software (R Project for Statistical Computing, Vienna, Austria) integrated within PearlDiver with an  $\alpha$  level set to 0.05. Demographic and clinical characteristics were compared using chi-square analysis for categorical variables. Univariable logistic regression for each postoperative joint complication was used to identify confounding variables amongst the examined demographic variables and comorbidities. Multivariable logistic regression was then used to calculate odds ratio (OR) and corresponding 95% confidence intervals (C.I.s) for the primary outcomes. Potential confounders adjusted for included sex, CCI, BMI, comorbidities, tobacco use, diabetes mellitus, rheumatoid arthritis, PVD, dementia, liver disease, CHF, CAD, IHD, PHD, CKD, and hypertension.

## RESULTS

### STUDY POPULATION

After exclusion criteria were applied and both cohorts were matched, 2,190 patients were assigned to both the conversion cohort and the THA cohort. By matching patients across gender, there was an equal representation for both cohorts of 740 males and 1,450 females. For BMI, the conversion cohort had a greater percentage of patients with a BMI classification <30 (25.30% vs 21.00%,  $p < 0.001$ ), while the THA cohort had a greater percentage of patients with a BMI classification between 30–40 (12.88% vs 15.80%,  $p$

**Table 1. Comparison of gender, BMI, and comorbidities between conversion and THA cohort**

Demographic Variable	Conversion Group (n=2,190) n (%)	THA Group (n=2,190) n (%)	P
Gender, n (%)			
Male	740 (33.79)	740 (33.79)	1.00
Female	1,450 (66.21)	1,450 (66.21)	1.00
BMI **, n (%)			
<30	554 (25.30)	460 (21.00)	<0.001
30-40	282 (12.88)	346 (15.80)	<0.001
40+	126 (5.75)	150 (6.85)	0.106
Specific Comorbidities, n (%)			
Tobacco Use	478 (21.83)	310 (14.16)	<0.001
Rheumatoid Arthritis	164 (7.49)	132 (6.03)	0.054
Liver Disease	148 (6.76)	162 (7.40)	0.409
CHF	359 (16.39)	253 (11.55)	<0.001
CAD	757 (34.57)	687 (31.37)	0.024
Pulmonary Heart Disease	740 (33.79)	665 (30.37)	0.015
Ischemic Heart Disease	164 (7.49)	147 (6.71)	0.317
COPD	694 (31.69)	646 (29.50)	0.116
Chronic Kidney Disease	363 (16.58)	380 (17.35)	0.494
Dementia	70 (3.20)	30 (1.37)	<0.001
Diabetes Mellitus	786 (35.89)	854 (39.00)	0.034
Hypertension	1,758 (80.27)	1,665 (76.03)	<0.001
PVD	508 (23.20)	524 (23.93)	0.569

THA, Total Hip Arthroplasty; BMI, Body Mass Index; PVD, Peripheral Vascular Disease; CHF, Congestive Heart Failure; CAD, Coronary Artery Disease; IHD, Ischemic Heart Disease; PHD, Pulmonary Heart Disease; CKD, Chronic Kidney Disease; OR, Odds Risk; CI, Confidence Interval

\*\*BMI data was only available for 43.9% of patients in the conversion cohort and 43.7% of patients in the THA cohort

<0.001). The conversion cohort contained a larger proportion of patients with tobacco use (21.83% vs 14.16%,  $p < 0.001$ ), CHF (16.39% vs 11.55%,  $p < 0.001$ ), CAD (34.57% vs 31.37%,  $p < 0.001$ ), PHD (33.79% vs 30.37%,  $p < 0.001$ ), dementia (3.20% vs 1.37%,  $p < 0.001$ ), diabetes mellitus (35.89% vs 39.00%,  $p < 0.001$ ), and hypertension (80.27% vs 76.03%,  $p < 0.001$ ) ([Table 1](#)).

#### MULTIVARIABLE ANALYSIS

For all joint complications examined at 1 year post-surgery using multivariable analysis, patients in the conversion cohort had significantly increased rates compared to the THA cohort. This included prosthetic joint dislocation (0.59% vs 0.18%: OR 2.95; 95% CI 1.02-10.65), PJI (8.68% vs 0.73%: OR 1.38; 95% CI 1.12-1.71), periprosthetic fracture (1.64% vs 0.50%: OR 2.95; 95% CI 1.79-4.88), aseptic loosening (2.51% vs 0.18%: OR 6.86; 95% CI 4.64-10.23), and revision (1.19% vs 0.18%: OR 3.65; 95% CI 2.57-5.20) ([Table 2](#)). At 2 years post-surgery, the conversion cohort still exhibited significantly increased rates of joint complications. Prosthetic joint dislocation (0.73% vs 0.18%: OR 3.77; 95% CI 1.36-13.31), PJI (9.63% vs 0.86%: OR 2.13; 95% CI 1.22-3.89), periprosthetic fracture (2.32% vs 0.59%: OR 3.75; 95% CI 2.24-6.45), aseptic loosening (2.92% vs 0.32%: OR 7.70; 95% CI 5.02-12.18), and revision (1.46% vs 0.32%: OR 6.73; 95% CI 4.58-10.12) were all more likely for patients that underwent conversion THA ([Table 2](#)).

#### DISCUSSION

With HA and THA being available treatment options for both femoral neck fractures and end-stage hip arthritis, the early failure of HA requiring conversion to THA represents an increased challenge to arthroplasty surgeons. This present study demonstrates that despite controlling for multiple confounding variables, there still exists an increased risk associated with hip conversion to a THA. Patients who underwent conversion had increased risks of prosthetic joint dislocation, PJI, periprosthetic fracture, aseptic loosening, and revision at both 1 and 2 years post-surgery. Each complication examined varied in its risk based on age, gender, BMI, and specific comorbidity. These postoperative complications can be devastating to the patient and surgeon. They also utilize greater resources without commensurate reimbursement, as Sodhi et al. demonstrated less Relative Value Units (RVUs) per minute for conversions compared to elective THA.<sup>21</sup>

One of the highest documented postoperative complications in conversion from a HA to THA is prosthetic dislocations.<sup>19,22</sup> Sarpong et al. examined 60 patients who underwent conversion from HA to THA and reported a 6.7% dislocation rate in their conversion group.<sup>22</sup> Similarly, Sah and Estok demonstrated in a patient cohort of 79 HA to THA conversions over an eleven-year period, there was a 22% dislocation rate compared to revision THA from a primary THA, which carried an 11% dislocation rate.<sup>19</sup> In our study, rates were comparatively higher for the conversion cohort than the THA cohort (1-year: 0.59% vs. 0.18%; 2 years: 0.73% vs. 0.18%).

**Table 2. Comparison of complications between conversion and THA cohort**

Complications	Conversion Group (n=2,190) n (%)	THA Group (n=2,190) n (%)	OR (95% CI)
Prosthetic Joint Dislocation			
1 year	13 (0.59)	4 (0.18)	<b>2.95 (1.02-10.65)</b>
2 year	16 (0.73)	4 (0.18)	<b>3.77 (1.36-13.31)</b>
Prosthetic Joint Infection			
1 year	190 (8.68)	16 (0.73)	<b>1.38 (1.12-1.71)</b>
2 year	211 (9.63)	19 (0.86)	<b>2.13 (1.22-3.89)</b>
Periprosthetic Fracture			
1 year	36 (1.64)	11 (0.50)	<b>2.95 (1.79-4.88)</b>
2 year	51 (2.32)	13 (0.59)	<b>3.75 (2.24-6.45)</b>
Aseptic Loosening			
1 year	55 (2.51)	4 (0.18)	<b>6.86 (4.64-10.23)</b>
2 year	64 (2.92)	7 (0.32)	<b>7.70 (5.02-12.18)</b>
Revision			
1 year	26 (1.19)	4 (0.18)	<b>3.65 (2.57-5.20)</b>
2 year	32 (1.46)	7 (0.32)	<b>6.73 (4.58-10.12)</b>

THA, Total Hip Arthroplasty; OR, Odds Risk; CI, Confidence Interval

A second frequent complication reported after HA conversion to THA is loosening of the prosthetic components, with rates previously reported between 2.3-10% with a mean follow-up of 6-7 years.<sup>23,24</sup> In comparison, this study found rates of aseptic loosening to be at 2.51% 1-year post-surgery and 2.92% 2 years post-surgery, both of which were significantly higher than rates of aseptic loosening in the primary THA cohort. These observed rates of loosening can be attributed to a variety of factors such as cementing technique, stem design, and bone resorption rate due to a potential increase in osteoporotic bone in the fragility fracture cohort.<sup>23,25</sup> While it is not possible with a large database to identify surgical technique or type of stem design used, this study demonstrates that aseptic loosening is a risk factor that arthroplasty surgeons must take into consideration when performing conversion surgery.

Using the clinical practice guidelines from the American Academy of Orthopaedic Surgeons 2019,<sup>26</sup> to identify risk factor comorbidities associated with PJI, multivariable logistic regression was used to diminish the confounding effect of these comorbidities. Despite the utilization of multivariable logistic regression, rates of PJI were still significantly higher for the conversion cohort compared to the THA cohort at both 1 and 2 years post-surgery (1-year: 8.68% vs. 0.73%; 2 years: 9.63% vs. 0.86%). In a similar study by Sarpong et al. comparing conversion THA, primary THA, and revision THA, despite not reaching significance, it was found that conversion THA had a 1.7% PJI rate at 2 years follow-up, in comparison to the 0% rate found in the primary THA group.<sup>12</sup> After controlling for multiple variables on the incidence of PJI, this study demonstrates that conversion carries with it an increased risk of PJI. With an increased risk of failure due to revision at both 1 and 2 years following conversion, the conversion cohort demonstrated significantly higher rates of revision in comparison to the primary THA cohort. Further research is warranted to examine the relationship between conversion to THA and PJI.

This study has several limitations. With the utilization

of a large database, it is not possible to identify different surgical techniques and stem designs used in the HA to THA conversion surgery. Complications were examined for 1 and 2 year post-surgery time periods; therefore, rates of examined complications cannot necessarily be extrapolated to longer follow-up periods. However, this decision to investigate short to mid-term complications after conversion surgery was due to the majority of complications occurring in the year following initial conversion surgery. In addition, the complexity of medical billing requiring manual input of diagnostic and procedural codes creates the possibility of coding bias. However, these errors are inherent with any database study using administrative claims information. The Center for Medicare and Medicaid (CMS) study demonstrated that such instances make up only 1.0% of overall payments.<sup>27</sup> Despite the code CPT-27236 being the selected code of choice for HA for femoral neck fractures, this code does include ORIF for the same indication. Thus a small number of patients in the conversion cohort may have received conversion from ORIF. Finally, despite utilizing multivariable logistic regression to diminish the effect of confounders, the influence of confounders may still exist.

This study is unique in that it utilizes multivariable logistic regression to diminish the effect of multiple confounding variables on rates of postoperative complications in a large sample, thus allowing for confidence in extrapolating the data to the general population when comparing elective THA to conversion THA from HA.

## CONCLUSION

While conversion to a THA is still a frequently performed operation for the failure of HA, this study demonstrates that it carries a higher risk profile for multiple joint complications in short to mid-term follow-up period than primary elective THA.

CONFLICTS OF INTEREST

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## SUPPLEMENTARY MATERIALS

### Appendix Table A1

Download: <https://orthopedicreviews.openmedicalpublishing.org/article/25539-complication-rates-of-hemiarthroplasty-conversion-to-total-hip-arthroplasty-versus-primary-total-hip-arthroplasty/attachment/65538.docx>

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