



A systematic review and meta-analysis of complications in conversion arthroplasty methods for failed intertrochanteric fracture fixation



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ABSTRACT

Background: Conversion arthroplasty for failed primary fixation of intertrochanteric fractures can be achieved using various methods, including cemented total hip arthroplasty, uncemented total hip arthroplasty, hybrid total hip arthroplasty, and hemiarthroplasty. Complication rates vary between each conversion method. The purpose of this paper is to examine the effect of conversion method on total conversion complication rates.

Methods: We performed a meta-analysis of five studies with sufficient data for analysis. We created a null hypothesis stating that the expected distribution of complications across conversion methods would reflect the distribution of conversion method used for failed primary fixation. Using a z test, we compared proportions of the expected distribution of complications to the observed distribution of complications. **Results:** A total of 138 cases of conversion arthroplasty with 49 complications were available for analysis. The mean age was 73 (range, 32–96) years. 19 males and 48 females were included, with one study not including patient gender. The mean time from primary fixation failure to conversion was 11 months, and the mean duration of conversion surgery was 132 min. Expected and observed complication rate distributions were as follows: cemented total hip arthroplasty, 6.5% versus 4.1% ($p = 0.79$); uncemented total hip arthroplasty, 77.5% versus 81.6% ($p = 0.69$); hybrid total hip arthroplasty, 2.9% versus 2.0% ($p = 1$); and hemiarthroplasty, 13% versus 12.2% ($p = 1$).

Conclusions: Our findings suggest that the method of conversion arthroplasty following failed primary intertrochanteric femur fracture fixation does not influence complication rate.

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1. Introduction

Intertrochanteric fractures are a common injury in the elderly, comprising 42.0% of all hip fractures and 85.1% of extracapsular femoral fractures within this population.¹ There is a 15% mortality rate among elderly patients with intertrochanteric fractures, which accounts for the highest mortality rate for all hip fractures among

this age group.² Internal fixation is the most commonly used treatment option for these fractures as it preserves natural bone stock; however, some studies have found failure rates as high as 16% for internal fixation of intertrochanteric fractures.³ Although arthroplasty (conversion) is an effective salvage procedure after failed primary fixation, the best method of conversion remains debated.^{4–11} Conversion arthroplasty methods can be divided into four groups: cemented total hip arthroplasty (CTHA), uncemented total hip arthroplasty (UCTHA), hybrid total hip arthroplasty (HTHA), and hemiarthroplasty (HEA). Each method may be indicated for various reasons, including bone quality, method of failed primary fixation, and medical comorbidities.^{9,12}

Although arthroplasty can provide pain relief, improve functionality, and reduce complications associated with immobility, complication rates for these conversions are generally high, and there is a common consensus that they present a technical

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challenge for surgeons.^{9–11,13–18} Reported complication rates for conversion arthroplasty widely range from 10% to 66%.^{13,19} A few retrospective studies have been conducted which compare complication rates between some selected conversion methods, but none have compared complication rates across all four methods of conversion arthroplasty. The purpose of this study is to perform a meta-analysis of complication rates across different conversion methods while also providing a brief systematic review of the literature on this topic. We hypothesize that the method of conversion arthroplasty for failed primary intertrochanteric femur fracture fixation will not influence complication rates.

2. Methods

This study did not require Institutional Review Board approval as all data was obtained from publicly available information. We performed a thorough literature review using PubMed, Embase, Cochrane Library, and Scopus, searching from each database's inception through February 2017. The following search terms were used in various combinations: "conversion," "intertrochanteric fracture fixation," "failure," "proximal hip," "total hip arthroplasty," and "salvage". Articles were reviewed for references to other potentially eligible studies. No language restrictions were used.

A total of 26 studies were reviewed which matched our initial search criteria, and of those, five studies had sufficient data to be included in our study. Studies with adequate documentation and categorization of conversion methods and respective complications were included. We categorized patients with both cemented acetabular and femoral components as CTHA, both components uncemented as UCTHA, patients with both a cemented and uncemented component as HTHA, and patients receiving only a femoral component as HEA. Demographics, operative characteristics, method of initial fixation, method of conversion arthroplasty, and complications were summarized using descriptive statistics (Table A1).

We performed a meta-analysis of five studies with sufficient data for analysis. We created a null hypothesis stating that the expected distribution of complications across conversion methods would reflect the distribution of conversion method used for failed primary fixation. Using a z test, we compared the expected distribution of complications to the observed distribution of complications. Comparing distributions allowed us to account for the varying frequencies of occurrence of each method of arthroplasty in our sample. We determined our observed distribution of complications by dividing the complications from each method by the total number of complications: CTHA (2/49), UCTHA (40/49), HTHA (1/49), and HEA (6/49). The frequency of occurrence of each method was determined by dividing the

number of patients receiving each method of arthroplasty by the total number of conversions: CTHA (9/138), UCTHA (107/138), HTHA (4/138), and HEA (18/138). Statistical analyses were performed using R 3.3.0 from the R Foundation for Statistical Computing. A *p* value <.05 was considered statistically significant.

3. Results

A total of 138 cases of conversion arthroplasty for failed primary intertrochanteric hip fracture fixations were analyzed. The average age of all patients was 73 (range, 32–96) years. The mean duration from the time of failure of the primary fracture fixation to the time of conversion arthroplasty was 11 months, and the mean duration of conversion surgery was 132 min. A total of 49 complications were recorded across all conversion method types.

Conversion method used was distributed as follows: 6.5% (9/138) CTHA; 77.5% (107/138) UCTHA; 2.9% (4/138) HTHA; and 13% (18/138) HEA. Complications were distributed as follows: 4.1% (2/49) for CTHA; 81.6% (40/49) for UCTHA, 2.0% (1/49) for HTHA (1/49); and 12.2% (6/49) for HEA. Comparisons of expected and observed distribution of complication rates did not reveal any statistically significant relationship (*p* > .05). Complication rates of each method were 22.2% for CTHA (2 complications out of 9 CTHA), 37.4% for UCTHA (40/107), 25.0% for HTHA (1/4), and 33.3% for HEA (6/18) (Table A2).

4. Discussion

Failure of primary fixation of intertrochanteric femur fractures occurs may occur in up to 16% of cases.³ Following such failures, the hip joint can be salvaged through an arthroplasty procedure.^{5,9,10,12–16,19–24} While majority of these arthroplasty procedures are performed as uncemented total hip (UCTHA) procedures, other approaches include cemented total hip arthroplasty (CTHA), hybrid total hip arthroplasty (HTHA), and hemiarthroplasty (HEA).^{11,23} The literature has shown varying complication rates for each method of conversion arthroplasty.^{5,10,11,15,21,23} However, no studies have directly compared the complication rates between the four conversion methods. This study systematically compared the complication rates between all four methods of conversion arthroplasty. To achieve this systematic comparison, we formulated an assumption that pooled reported complications in the literature would distribute between the four methods of conversion in a manner that reflects how frequently a conversion method was used. In essence, we assumed that the more frequently a conversion method was used/reported, the more frequently complications would be attributed to that method of conversion.

Table A1
Demographics and raw study data.

	Mortazavi, Greenky, Bican, Kane, Parvizi, and Hozack ¹⁵	Shi, Zhou, Yang, Shen, Kang, and Pei ¹⁰	Cho, Yoon, and Kim ⁵	Srivastav, Mittal, and Agarwal ²¹	Castillon, Bartra, Vallejo, Salvador, Torres, and Angles ²³
Study Duration (months)	96	79	120	132	168
Average Age (years)	73.3	72.4	70.5	69.4	76
Sex (M, F)	NR, NR	12, 19	4, 5	3, 7	0, 17
Mean Time to Revision (months)	NR	8.2	13.6	22.3	8.2
Mean Surgical Time (min)	124	136	194.5	125	NR
Conversions CTHA, UCTHA, HTHA, HEA	0, 71, 0, 0	0, 31, 0, 0	0, 0, 0, 9	5, 4, 1, 0	4, 1, 3, 9
Complications CTHA, UCTHA, HTHA, HEA	0, 24, 0, 0	0, 14, 0, 0	0, 0, 0, 3	1, 2, 0, 0	1, 0, 1, 3
Initial Fixation Nail, Plate, DHS	10, 61, 0	8, 6, 17	4, 0, 5	2, 1, 7	12, 5, 0

*NR = Not recorded.

Table A2

Distribution of conversions and complications by conversion arthroplasty method.

	Total Conversions (n)	Total Complications (n)	Total Complication Rate (%)	Observed Complication Distribution (%)	Expected Complication Distribution (%)	p value
CTHA	9	2	22.2 (2/9)	4.1 (2/49)	6.5 (9/138)	0.79
UCTHA	107	40	37.4 (40/107)	81.6 (40/49)	77.5 (107/138)	0.69
HHTA	4	1	25.0 (1/4)	2.0 (1/49)	2.9 (4/138)	1.0
HEA	18	6	33.3 (6/18)	12.2 (6/49)	13.0 (18/138)	1.0
Total	138	49	35.5 (49/138)			

CTHA = Cemented Total Hip Arthroplasty; UCTHA = Uncemented Total Hip Arthroplasty; HHTA = Hybrid Total Hip Arthroplasty (containing both cemented and uncemented components); HEA = Hemiarthroplasty

Our null hypothesis stated that we expected the distribution of total complications for each method of conversion arthroplasty to be similar to the distribution of conversion method used for management of failed primary fixation. For example, if 20% of failed primary fixations were converted using CTHA, we expected that 20% of the total complications would occur in the CTHA conversion group. This hypothesis was supported by our findings, which showed that the expected distribution of the total complications across conversion methods and the observed distribution were not significantly different ($p > .05$).

These findings are meaningful because recent literature shows each of the four methods of conversion arthroplasty to be an acceptable treatment for failed internal fixation of intertrochanteric fractures, but some authors have stated that various methods may be better options than others.^{5,10–12,23} In one retrospective study of 79 patients from a single institution, Tsai, Chen, Wu, Huang, Chen, and Chang concluded that either cemented standard stems or cementless diaphyseal locking stems may be better options than cementless standard metaphyseal locking stems due to lower complications (33.3%, 65.5%, and 97.6%, respectively).¹¹ In a study of 21 CTHA, 5 UCTHA, and 7 HEA patients, Hammad, Abdel-Aal, Said, and Bakr stated that cemented stems were preferred in older patients with poor bone quality or a wide medullary canal. They recorded an overall complication rate of 68.8%, but with relatively few major complications.¹² Shi, Zhou, Yang, Shen, Kang, and Pei believe that uncemented stems provide preferable advantages over cemented stems.¹⁰ Variances in findings and opinion across studies may be due to differences in typical comorbidities and patient populations between institutions, differences in performance of the chosen implants models, and various other confounders and biases. One of the strengths of this study is that it minimizes the impacts of bias and confounding variables in individual retrospective studies by analyzing a larger study group compiled from multiple studies. Our findings from analysis of this combined data either suggest that surgeons are appropriately matching patients to the proper method of conversion arthroplasty or that regardless of the indications, conversion methods are equivalent in their rate of complication. To clarify these possibilities, future randomized prospective studies will be beneficial.

Although complication rates vary by conversion method, it appears that conversion arthroplasty outcomes may be more associated with other variables, such as method of primary internal fixation, surgical technique, and implant model (i.e., long stem vs. short stem) as opposed to conversion type. This can be inferred from recent literature, which emphasizes the importance of proper stem selection and surgical technique based on patient indications, such as patient age and bone quality.^{4,12} Stress risers from cortical holes can cause intraoperative femur fractures associated with the use of cementless femoral stems, an issue mitigated by use of a long stem component.¹³ Alternatively, proper cement pressurization with cemented femoral stems can be achieved by using careful surgical technique, despite remaining cortical holes in the femur following primary fixation hardware

removal.¹² Understanding that the proper choice for method of arthroplasty is dependent on each patient's indications rather than complication rates of each method may aid surgeons in evaluating each patient individually, leading to better outcomes of conversion arthroplasty. In addition, good outcomes can be achieved with all methods of conversion when proper surgical technique is applied.

This study has several limitations. We were not able to provide explanations for conversion arthroplasty complications, but only suggest that the total number of complications are distributed proportionally between different methods of arthroplasty. The combined data sets for CTHA, HHTA, and HEA were relatively small compared to UCTHA, with the UCTHA group being roughly 5 times larger than HEA, the next largest group in the study. Additionally, the total study group of 138 patients was small. Available data did not allow for the HEA group to be divided into cemented or cementless stem components. This study considered all complications as one group, and did not consider the relative severity of each complication. In addition, other outcome metrics, such as Harris Hip Score and other functional outcome measures, were not considered in this study.

Although there are many limitations, we do not believe they diminish the usefulness of this study. In addition to being the only available meta-analysis of conversion arthroplasty complications associated with various arthroplasty methods, this is the only study available that investigates complication rates among all four methods of conversion arthroplasty after failed primary intertrochanteric femur fracture fixation.

In conclusion, conversion arthroplasty for failed internal intertrochanteric fracture fixation is challenging, but our findings suggest that the rate of total complications is comparable among CTHA, UCTHA, HHTA, and HEA. From these findings, we suspect that all four methods of conversion are acceptable salvage procedures for failure of primary internal fixation of intertrochanteric fractures; however, due to limitations within this study we do not draw any definitive conclusions, and future prospective studies on this topic are recommended.

Conflict of interest

None.

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