



A systematic review of the causes of failure of Revision Total Hip Arthroplasty

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ABSTRACT

This study reviewed literature published in the last 10 years to investigate the reasons for revision failure. A total of 9952 revisions were identified and it was determined that the number one cause of failure was aseptic loosening (23.19%), followed by instability (22.43%) and infection (22.13%). Further analysis of applicable revisions investigated BMI and age at the failure rates. The rate of rerevision in obese patients was markedly higher ($p < 0.01$) compared to non-obese patients and individuals receiving a revision THA under the age of 55 are at a higher risk of rerevision ($p < 0.01$).

1. Introduction

The success of total hip arthroplasty (THA) is well documented with success at 10 years exceeding 90%.¹ Primary THA in the United States is on the rise with the procedure being completed earlier and more often than in prior years. Compared to 2005, primary THA is expected to have increased by 175% by 2030.² The increase in primary THA and the earlier use of joint replacement in some patients is resulting in increased burden of revision THA. Compared to 2005, revision THA is expected to have increased by 137% by 2030.^{2,3} Revision surgery poses increased risk of complications and it is shown that patients are five times more likely to undergo a rerevision compared to revision of a primary THA.⁴ Advancements have been made in THA, including newer implant designs and updated surgical techniques, but as predicted by Kurtz et al. the burden of revision is still expected to increase.³ Therefore, the need to understand the risks and causes of failures is greatly needed to help implement better preventative methods. Currently, the literature has found either instability, infection, or aseptic loosening to be leading causes of revision failure, but the studies making these claims have some limitations.^{5–7} Khatod et al. investigated factors associated with rerevision and found the leading cause to be instability (42.9%), followed by infection (28.6%), and aseptic loosening (9.5%). However, the study had a limited sample size of 629 revisions and was narrow in focus, only exploring revisions that had been completed for aseptic reasons.⁵ Likewise, Springer et al. found instability to be the leading cause of rerevision (35%), followed by aseptic loosening (30%), and infection (12%). However, the study also had a limited sample size of 1100 revisions and data tracing back to 1986.⁶ An additional study

by Jafari et al. found infection to be the leading cause of failure (30.2%), followed by instability (25.1%), and aseptic loosening (19.4%). Similarly, this study was limited by its sample size.⁷ The three studies found aseptic loosening, infection, and instability to be the leading causes of failure, but the rates of failure varied by up to 20%. While the studies were comparable, it shows the need for a review to address these limitations and mitigate the issues to determine a more encompassing failure rate of revisions leading to rerevisions.

The purpose of this study is to conduct a broad review of the current published data to address the risk of rerevision while mitigating some the limitations noted in the current literature. Revision THA will be reviewed to determine the causes of any rerevisions and the data will be compiled to address the failure rates.

2. Methods

2.1. Study design

A systematic literature review was conducted to determine the risk of revision failure in THA. Rerevision was defined as a revision of any component of a revision THA system. The literature review was completed utilizing PubMed. The search was limited to Randomized Control Trials published within the last 10 years utilizing PubMed's filtering system. Terms such as "Hip Revision Failure", "Revision Total Hip Arthroplasty", or "Total Hip Arthroplasty" were used to isolate a broad base of papers from which to screen and select for further review and data extraction.

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Table 1
Breakdown of extracted data.

Revisions	Failures	Aseptic Loosening	Dislocation	Infection	Instability	Mechanical Complications	Bone Fracture	Component Fracture	Pain	Wear	Other	Ref#
204	8	2	2	0	4	0	0	0	0	0	0	8
99	23	6	7	7	0	0	2	0	0	0	1	9
68	7	0	4	0	3	0	0	0	0	0	0	10
2596	353	116	78	88	0	0	29	19	11	0	12	11
75	8	2	0	5	0	0	0	0	1	0	0	12
3555	472	0	109	142	34	82	0	0	0	0	105	13
1780	159	129	18	1	0	0	0	0	0	0	11	14
86	13	0	3	1	2	0	2	0	0	0	5	15
103	32	12	0	3	10	0	0	0	0	1	6	16
51	1	0	0	1	0	0	0	0	0	0	0	17
72	11	6	1	2	0	0	1	0	0	0	1	18
53	20	2	4	4	0	0	2	0	0	0	8	19
47	7	0	2	5	0	0	0	0	0	0	0	20
118	10	0	10	0	0	0	0	0	0	0	0	21
77	42	18	6	2	0	0	5	1	0	10	0	22
161	23	3	7	10	0	0	2	1	0	0	0	23
612	95	0	44	11	26	0	4	0	10	0	0	24
112	24	6	0	6	6	0	3	3	0	0	0	25
83	7	3	0	3	0	0	0	1	0	0	0	26
9952	1315	305	295	291	85	82	50	25	22	11	49	–

2.2. Selection criteria

From the output of PubMed, the titles were reviewed to pull papers with reference to revision or rerevision THA. The abstracts of these papers were reviewed to determine if eligibility criteria were met, which included: subject involving THA revision for any reason and subject including rerevision rates and their causes. Papers that met criteria were reviewed in their entirety and used for data extraction and compilation (Table 1).

2.3. Data analysis

The revision data was extracted to determine the cause for any re-revision reported throughout the study. This was used to determine which causes had the highest risk of failure of a THA. Further data was extracted to compare the outcomes of revision surgery between obese ($\leq 30 \text{ kg/m}^2$) and non-obese ($< 30 \text{ kg/m}^2$) individuals, and individuals < 55 years and ≥ 55 years old. We calculated standard descriptive statistics to determine the failure rates and breakdown of failure modes. A chi squared test was utilized to determine statistical difference between the comparison groups.

3. Results

A total of 9952 revision THAs were evaluated from 19 studies, Table 1. A rerevision for any reason was reported in 1315 cases, resulting in a failure rate of 13.21%. Of the failures, aseptic loosening comprised the largest percent of the total number of failures (23.19%). This was followed by instability (22.43%) and infection (22.13%). The remaining 32.25% of failures was a result of several other failure modes including: mechanical complications, implant failure, fracture, and pain, and other (Table 2).

The data from the 19 studies was further broken down into patient populations based on either body mass index (BMI) or age to determine whether there was a statistically significant outcome in rerevision between those groups and in regard to the mode of failure. Not all studies reported BMI or age breakdown for a given failure.

3.1. BMI outcome

9952 revision hips were reviewed in total and from this data set, 415 hips could be further studied to investigate outcomes given BMI and failure classification. There were 197 revisions completed on obese

Table 2
Breakdown of hip revision failure.

Failure Mode	Total Number of Failures	Percent of Total Failures	Percent of Revisions
Aseptic Loosening	305	23.19%	3.06%
Dislocation	295	22.43%	2.96%
Infection	291	22.13%	2.92%
Instability	85	6.46%	0.85%
Mechanical Complications	82	6.24%	0.82%
Bone Fracture	50	3.80%	0.50%
Component Fracture	25	1.90%	0.25%
Pain	22	1.67%	0.22%
Wear	11	0.84%	0.11%
Other	149	11.33%	1.50%

individuals and 218 revisions on non-obese individuals. Rerevisions were reported in 42 obese and 11 non-obese individuals, with the rate of obesity in rerevision groups being markedly higher ($p < 0.01$) in comparison to non-obese individuals (Table 3). There were no statistical differences between the individual failure modes.

3.2. Age outcome

9952 revision hips were reviewed in total and from this data set, 3735 hips could be further studied to investigate outcomes given age and failure classification. There were 180 revisions completed on individuals < 55 years-old and 3555 revisions completed on individuals ≥ 55 . The total number of failures were 74 and 472, respectively.

Table 3
Revision failure in obese in non-obese patients.

Failure Mode	Non-Obese	Obese	Chi Squared Test p value
	218 Revisions	197 Revisions	
Total Failures	11	42	7.05E-07
Aseptic Loosening	3	11	0.94
Instability	2	8	0.95
Dislocation	4	5	5.44E-02
Infection	1	12	0.18
Bone Fracture	1	4	0.97
Component Fracture	0	3	0.36
Other	0	1	0.61

Table 4
Comparison of revision failure rates in younger and older patients.

Failure Mode	< 55	55 +	Chi Squared Test p value
	180 Revisions	3555 Revisions	
Total Failures	74	472	6.20E-25
Aseptic Loosening	30	0	6.02E-46
Instability	10	34	6.37E-02
Dislocation	6	109	3.23E-03
Infection	5	142	2.59E-05
Wear	11	0	2.62E-17
Bone Fracture	5	0	1.40E-08
Component Fracture	1	0	1.15E-02
Mechanical Complication	0	82	1.00E-04
Other	6	105	4.96E-03

Individuals receiving a revision THA under the age of 55 are at a higher risk of rerevision ($p < 0.01$). Modes of failure that showed no difference between the groups were instability and component fracture. All other groups showed statistically significant differences between younger and older individuals (Table 4).

4. Discussion

While Jafari, Khatod, and Springer concluded that aseptic loosening, infection, and instability were the leading causes of rerevision, the percent of failures were inconsistent. During the literature review, instability included dislocation under its classification, which was separated out into two separate categories for failure modes. Similar to the literature reported, this study found aseptic loosening and infection to be major causes of rerevision as well as instability accounting for nearly two-thirds of the total failures. Within the sample size, comparisons were made between BMI and age to investigate any associated risks for rerevision within these subgroups. It was shown the BMI increases the risk of rerevision, so it can be hypothesized that with steps taken to reduce BMI, an individual receiving a revision THA could potentially reduce their risk of needing a rerevision. However, while BMI is a risk that can be addressed and potentially mitigated, age is an additional barrier. Implants have been shown to have a limited lifespan of ~10–20 years, hence when receiving them at a younger age, it is more likely to require revision at some point. However, it was shown that there was no statistical difference between the age groups when looking at instability or component failure. Rather, the differences were in the other failure modes, including aseptic loosening and infection. This warrants further study as to why the younger age group shows increased incidence in failure modes other than the life expectancy of the implant.

4.1. Limitations

This study was limited by the available randomized trials available for review evaluating the failure modes of revision hip systems. The primary limitation of this study is information as to the cause for the initial revision THA was not always available and thus could not be accounted for in the analysis. Furthermore, the compilation of studies introduces some uncontrolled variables including component choices, surgical approaches, and variation between surgeons. There was sometimes a lack of information on gender, BMI, and age accounting for discrepancies between the total revision number utilized to determine incidence risk and then the total revision number utilized in BMI and age comparisons. For all hips evaluated, having a complete history for

each hip would greatly strengthen the results found in this study. Additionally, the inclusion of information on acetabular and femoral bone loss could expand the classification to determine the region of failure and if modification to implant design could mitigate that risk.

Conflicts of interest

All authors have nothing to disclose.

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