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Re-revision total hip arthroplasty: Epidemiology and factors associated with outcomes

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ABSTRACT

Introduction: The epidemiology of re-revision total hip arthroplasty (THA) is not yet well-understood. We aim to investigate the epidemiology and risk-factors that are associated with re-revision THA.
Methods: 288 revision THA were analyzed between 1/2012 and 12/2013. Patients who underwent two or greater revision THA were included. Hips with first-revision due to periprosthetic joint infection (PJI) were excluded. Failure was defined as reoperation.
Results: 51 re-revision patients were available. Mean age was 59.6 (±14.2 years), 32 (67%) females, average BMI of 28.8 (±5.4), and median ASA 2 (23; 55%). The most common re-revision indications were acetabular component loosening (15; 29%), PJI (13; 25%) and instability (9; 18%). The most common indications for first revision in the re-revision population were acetabular component loosening (11; 27%), polyethylene wear (8; 19%) and instability (8; 19%). There was an increased risk of re-revision failure if the re-revision involved exchanging only the head and polyethylene liner (RR = 1.792; p = 0.017), instability was the first-revision indication (RR = 3.000; p < 0.001), and instability was the re-revision indication (RR = 1.867; p = 0.038). If isolated femoral component revision was indicated during the re-revision, there was a decreased risk of failure (RR = 0.268, p = 0.046). 1-year re-revision survival was 54% (23/43).
Discussion: Acetabular component loosening, instability, and PJI were the most common indications for re-revision. Revision due to instability is a recurrent problem that leads to re-revision failure. There was a higher infection rate in the re-revision population compared to published revision PJI. A better understanding of the indications and patient factors that are associated with re-revision failures can help align surgeon and patient expectations in this challenging population.

1. Introduction

The incidence of primary total hip arthroplasty (THA) has been increasing, with projections suggesting that, from 2005 to 2030, the annual incidence of primary THA will increase by 174%, reaching approximately 572,000 per year.[1] Consequently, revision and re-revision burden of THA may also increase dramatically. Currently, approximately 18% of all THA performed in the United States are revision procedures.[2] This accounts for approximately 50,000 annual THA procedures.[3]

While revision THA does provide clinical benefits and patient satisfaction,[4,5] these procedures are technically challenging and are frequently associated with inferior outcomes when compared to primary THA.[6,2] Revision procedures have been associated with higher post-operative complications such as aseptic loosening, periprosthetic fractures, infection, dislocation, and more difficult rehabilitation.[3,4] Additionally, compared to primary THA, aseptic revision THA has a reported higher 90-day re-admission, re-operation, infection, and mortality rates.[7] Patients undergoing revision THA are up to six times more likely to require subsequent revision operations than those undergoing a primary procedure.[2] A previously reported 5-year survival rate for primary THA is 95.9% but only 81.0% for revision THA.[2] A report of 4762 revision THA cases indicated a 10-year failure rate of 26%.[6]

Revision procedures place a significant economic burden on our health care system and pose significantly worse outcomes than primary THA procedures. In 2015, the Medicare expenses for

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revision THA exceeded $8.5 billion.[2] These costs will rapidly increase as the volume of THA procedures grow in the next few years, necessitating a need for the characterization of revision THA procedures and the factors influencing their outcomes. Much of the prior literature has focused on primary THA and the first revision procedures, yet the circumstances surrounding re-revision THA remain unknown. In this study we investigate the epidemiology, risk factors, and clinical outcomes associated with re-revision THA. A more thorough understanding of the indications and patient factors associated with re-revision THA and its outcomes will better align surgeon and patient expectations in the management of this challenging patient population. We hypothesize that instability and aseptic loosening to be common indications for re-revision as well as be associated with re-revision failure.

2. Methods

All revision total hip arthroplasty cases performed between January 1st, 2012 and December 31st, 2013 at a single tertiary academic institution were identified in order to analyze the circumstances surrounding failure of revision THA. Patients were included if they had undergone two or more revision THA procedures. Revision surgery was defined as any surgical intervention and return to the operating theater for complications of the operative hip following index THA. Patients were excluded if they had fewer than two revisions following index THA or if their indication for primary revision was for periprosthetic joint infection (PJI), encompassing patients who underwent irrigation and debridement, liner exchange, irrigation and debridement with single stage component exchange, or irrigation and debridement with two-stage component exchange.

Patient information was abstracted from the electronic medical record (Epic Systems Corporation, Verona, Wisconsin) in a retrospective manner. This includes demographic data such as age, gender, body mass index (BMI), past or present tobacco use, presence of a systemic inflammatory condition, presence of any immunocompromised state, ASA score, physician office visits, and available patient follow-up information. Time-specific demographic information such as age and BMI was recorded based on time of the index procedure. Also included in the review were operative reports of the index procedure and subsequent operations when available.

Descriptive statistics (IBM SPSS Statistics, Armonk, New York) were utilized to report the epidemiology of failed revision THA and re-revision THA procedures. Frequencies, means, and 95% confidence intervals were utilized to describe the study populations. The relative risks of each factor on revision failure were calculated. A p-value < 0.05 was utilized to determine statistical significance for all tests. A logistic regression analysis was performed to assess for significant predictors of re-revision failure.

3. Results

We identified a total of 288 consecutive patients undergoing revision THA at a single institution over the 2-year time interval defined in this study. Of those patients identified, 51 met the inclusion criteria outlined above. Mean age was 59.6 (±14.2 CI) years and average BMI was 28.8 (±5.4 CI). There were 34 females in the cohort (66.7% female). 27 (53%) patients had some history of smoking while 11 (22%) patients had a diagnosed systemic inflammatory condition requiring intervention. These conditions included but not limited to rheumatoid arthritis, psoriatic arthritis, and systemic lupus erythematosus. The cohort had 15 (29%) patients with some history of an immunocompromised state, defined as presence of diabetes mellitus, HIV or AIDS, Hepatitis, and current or past history of cancer. Table 1 is a summary of the demographic information of the patient cohort.

Table 1
Depicts the demographic information of our cohort.

Demographic Information	
n	51
Age	59.6 (±14.2)
BMI	28.8 (±5.4)
Female	34 (67%)
History of Smoking	27 (53%)
Inflammatory Condition	11 (22%)
Immunocompromised	15 (29%)

Indication for **primary revision** varied among the 51 patients who under-went rerevision: 10 (10/51; 20%) patients were revised for acetabular loosening, 8 (8/51; 16%) for polyethylene wear, 8 (8/51; 16%) for instability, 6 (6/51; 12%) for periprosthetic fracture, 3 (3/51; 6%) for femoral loosening, 2 (2/51; 4%) for a metal on metal reaction, and 5 (5/51; 10%) for miscellaneous indications which included implant fracture, and case-specific indications. **Re-revision** indications among the cohort were as follows: 12 (12/51; 24%) were revised for acetabular loosening, 4 (4/51; 8%) for polyethylene wear, 9 (9/51; 18%) for instability, 0 (0/51; 0%) for periprosthetic fracture, 4 (4/51; 8%) for femoral loosening, 0 (0/51; 0%) for a metal on metal reaction and 7 (7/51; 14%) for case-specific indications. There were 13 (13/51; 25%) re-revision procedures performed for the presence of a periprosthetic joint infection. Indications for both the primary revision and re-revision procedures are seen in Table 2.

85% of patients underwent the same surgical approach for the index, revision, and re-revision procedures. Regarding survival of the index components, 12% patients had a head and liner exchange only, 49% had only the acetabular component revised, 24% had only the femoral component revised, and 14% of patients had all components revised at some point during their treatment history, which includes the primary revision and all subsequent revision procedures. Therefore, patients with only head and liner exchange retained their original femoral and acetabular implants throughout each new surgery. Those with all components exchanged had the femoral implant, acetabular implant as well as head and liner exchanged over the course of their revision surgeries; however, these did not all have to be exchanged during the same procedure.

Of the re-revision procedures indicated for periprosthetic infection (13/51, 25%), the average age and BMI were 59.6 (±6.2) years and 30.6 (±2.8) respectively. This patient population had 7 females (7/13; 54% female) and included 8 (8/13; 62%) patients with a prior or current history of smoking. There were 5 (5/13; 39%) patients with systemic inflammatory illness as described above. Several patients that were re-revised for periprosthetic infections (4, 31%) had been diagnosed with nasal colonization of methicillin-sensitive or methicillin-resistant staphylococcus aureus (MSSA and

Table 2
Depicts the indications for both primary and re-revision surgery. PJI is not reflected under primary revision as these patients were excluded from the study.

Indication	Primary Revision	Re-Revision
Acetabular Loosening	10 (20%)	12 (24%)
Polyethylene Wear	8 (16%)	4 (8%)
Instability	8 (16%)	9 (18%)
Periprosthetic Fracture	6 (12%)	0 (0%)
Femoral Loosening	3 (6%)	4 (8%)
Metal on Metal Reaction	2 (4%)	0 (0%)
Case-Specific Indications	5 (10%)	7 (14%)
Periprosthetic Joint Infection	N/A	13 (25%)
Unknown indication	9 (18%)	2 (4%)

Table 3
Indicates the demographic data and speciation of the patients who underwent re-revision THA for a periprosthetic joint infection.

Re-Revision for PJI Demographic Information	
n	13
Age	59.6 (±6.2)
BMI	30.6 (±2.8)
Percent Female	54%
Smoking History	8 (62%)
Inflammatory Disease	5 (39%)
MSSA or MRSA colonization	4 (31%)
Cultured *s. aureus*	5 (38%)
Cultured *s. epidermidis*	3 (23%)
No growth via culture	5 (38%)

MRSA respectively) previously. Cultures were taken intra-operatively during these re-revision procedures and bacteriology revealed speciation for 8 patients. The reports indicated 5 (5/13; 38%) patients with staphylococcus aureus infections and 3 (3/13; 23%) with staphylococcus epidermidis periprosthetic joint infections. Management of the re-revision PJIs consisted of 9 (9/13; 69%) irrigation and debridement procedures, 1 (1/13; 8%) single-stage revision THA, 2 (2/13; 15%) two-stage revision THA, and 1 (1/13; 8%) resection arthroplasty. Management was successful in 7 (7/13; 53%) patients overall; 6 (6/9; 67%) irrigation and debridement patients, 0 (0/1; 0%) one-stage revision patients, and 1 (1/2; 50%) two-stage revision patient. Table 3 summarizes the demographics of the septic, re-revised THA patient cohort.

Ultimately, 27 (53%) of the 51 patients undergoing re-revision THA arthroplasty failed the re-revision procedure. The average number of revisions of each patient who failed re-revision THA was 3.9 (±0.7) procedures with the range of revision procedures for these patients of 3–11. Procedure survival analysis of the entire cohort indicated 83%, 71%, and 54% survival at 3, 6, and 12 months following re-revision surgery respectively. Survival was defined as need for any surgical intervention and return to the operating theater following re-revision THA.

Logistic regression analysis indicated that instability as an indication for primary revision was a statistically significant ($p < 0.001$) predictor of re-revision failure, conferring a relative risk of 3.0 (1.8–5.1). Instability as an indication for re-revision THA was also a statistically ($p = 0.038$) significant indicator of re-revision failure, with a relative risk of 1.9 (1.0–3.4). Among re-revisions, if the primary THA failed due to instability, there was a significantly higher risk of being re-revised for instability again (OR = 18.3; $p = 0.023$; 95%CI: 1.5, 222.9). Exchange of head and polyethylene liner only during the re-revision was a significant predictor of failure ($p = 0.017$) with a RR of 1.8 (1.11–2.90). Isolated exchanged of the femoral component during the time of the re-revision demonstrated a protective effect in terms of re-revision survival ($p = 0.046$; RR 0.268; 0.07–0.97). No other patient demographic or operative variables conferred a significant risk of re-revision THA failure. These results are summarized in Table 4.

4. Discussion

Re-revision THA is technically challenging and with poorly understood outcomes, and lacking robust evidence. There is an increasing demand of THA with a younger, more active population undergoing the procedure. As a result, the revision burden will in turn increase substantially and subgroup will be subject to enduring multiple revisions.[2] Outcomes in patients who undergo multiple revisions are significantly inferior to the primary surgery, as evidenced by our 1 year 54% re-revision survival.

The average age in our re-revision population was 59. Comparatively, the average age of patients receiving primary THA is between 65 and 70 years.[8] Younger age has been established as a risk factor for revision, as younger patients are generally a higher demand population and may subject their implants to higher magnitudes of joint forces.[9] This, in turn, increases risk of complications, such as implant loosening and dislocation, despite a technically sound operation.[2,9,10] Johnsen et al. demonstrated that patient ages 59 years or younger had a significantly higher risk of long-term THA failure.[10] Furthermore, in a Swedish registry study, young age was a significant predictor of THA revision.[11] In younger populations, especially patients below the age of 60, discussion of having at least one revision procedure should be emphasized.

The infection rate of revision THA leading to re-revision was also observed to be higher than the published PJI incidence following revision hip arthroplasty.[16] The explanation for this higher rate is likely multifactorial. First, the study cohort is small, and may possibly represent an over-estimation of the true re-revision infection rate. Second, the published PJI incidence among revision hip arthroplasty included first time revisions. Certainly the risk of infection increases with each subsequent revision procedure,[17] thus leading to a higher incidence of PJI among re-revisions, which has not yet been substantiated in the literature. Third, an “aseptic” first revision was assumed, though infection markers were trended and postoperatively the first revision hip was deemed to be “infection-free”. Our data suggests that it is possible that an indolent infectious process may have been present on what was assumed to be an aseptic revision and may or may not have contributed to failure of the primary arthroplasty, leading to the ultimate failure of the revision procedure. Infection in hip arthroplasty is certainly a challenging and evolving area where more evidence is needed to improve the infectious work up and management.

We found that instability was found to be associated with the greatest risk of re-revision failure. Instability is one of the most common reasons for revision and can result from a multitude of factors, from malposition of components to inherent patient characteristics (i.e weak abductor strength, cognitive dysfunction).[12–14] In a retrospective study investigating risk factors and outcomes associated with instability after revision THA, Albertson et al. concluded that instability was a common, re-current complication in revision THA and must be approached differently in the revision setting than standard primary considerations.[12] Our results confirm this notion where, among re-revision patients, those who were

Table 4
Risk factors with significant impact on re-revision survival.

Variable	Relative Risk	p value
Instability indicated for primary revision	3.0 (1.8–5.1)	<0.001
Instability indicated for re-revision	1.9 (1.0–3.4)	0.038
Exchange of head and liner only during re-revision	1.8 (1.1–2.9)	0.017
Exchange of femoral component only during re-revision	0.3 (0.07–0.97)	0.046

originally revised for instability were at significantly higher risk to be revised a second time for instability. Guo et al. in a meta-analysis found that re-revision was significantly associated with instability; and each subsequent revision after that posed a higher risk of recurrent instability.[14] In both the primary and revision setting, there is a need for more effective solutions in addressing instability after THA.

It is interesting to note that when a re-revision involved a femoral component exchange only, the re-revision procedure was more likely to succeed. One possible explanation for this finding is that current technique and implant technology is better at addressing femoral-sided indications than acetabular-sided pathology. Another explanation is that a femoral-only indication infers that the acetabular component was well-positioned and well-fixed, which in turn is a significantly less morbid operation than revision of both components. Good results have been reported in isolated femoral component revision cases, thus these findings are not surprising.[15]

There are several limitations to this study. First, this is a retrospective study; and there are limitations inherent to this study design, such as recall bias as well as wrong information being logged into the electronic medical record. This is unlikely to be a significant source of error, as the patients in this study needed very clear and complete documentation in order to be included. Secondly, this study examines a cohort of patients who have already reached the point of re-revision and the epidemiology is then retrospectively determined, thus our findings must be interpreted carefully. This study does not aim to determine factors leading to, or risk of re-revision, nor establishing a “re-revision rate”. Rather, this study aims to characterize the demographics of specifically re-revision patients and the factors that affect their short-term outcomes. Lastly, a large proportion of patients that were initially revised for PJI was excluded from this analysis. The path of an infected THA often involves multiple staged procedures, as well as a different pathological course. For this reason, only revisions that were re-revised for first time PJI were included.

Re-revision THA is relatively uncommon, however it is becoming more relevant as the incidence of THA is dramatically increasing on a younger, higher demand patient demographic. We found that patients who require re-revision THA are most commonly indicated for instability, PJI, and acetabular component loosening. Instability at any point during the revision history poses a significantly greater risk of enduring multiple revisions. Re-revision success was more likely if an isolated femoral component revision was indicated. More research is needed to characterize this challenging population.

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