

Causes of Revision Total Hip Arthroplasty in Twenty Years: an Analysis of 1,353 Revisions

Jianming Gu

Beijing Jishuitan Hospital, Fourth Clinical College of Peking University

Xiao Feng

Beijing Jishuitan Hospital, Fourth Clinical College of Peking University

Hongyi Shao

Beijing Jishuitan Hospital, Fourth Clinical College of Peking University

Yixin Zhou (✉ orthoyixin@yahoo.com)

Department of Orthopedic Surgery, Beijing Jishuitan Hospital, Fourth Clinical College of Peking University, Beijing, China <https://orcid.org/0000-0002-9682-0577>

Research article

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Abstract

Background

With the increase in revision total hip arthroplasty (THA) cases, understanding its causes is essential for a surgeons' clinical decision-making. Studies have reported on revision THA epidemiology in developed countries; however, its epidemiology in China remains unclear. We reviewed revision THA causes in a tertiary center in China.

Methods

We retrospectively identified 1,353 revision THAs at our institution from January 1999 to December 2018 (20 years). The causes for revision THA were compared among patients who were grouped based on the time of revision surgery, age at revision, and number of revisions, using the Student's *t*-test.

Results

Aseptic loosening (826 hips, 61.0%) and infection (151 hips, 11.2%) were the most common reasons for revision THA. Compared with the number of cases from January 1999 to December 2008, the number of cases from January 2009 to December 2018 increased 2.4-fold; the proportion of revisions due to aseptic loosening, periprosthetic fracture, instability, and osteolysis increased, and infection rate decreased. The infection rate was higher among patients aged over 60 years, whereas the incidence rate of aseptic loosening, periprosthetic fracture, and instability was higher among those aged 60 years or less. Infections (52.8%) were more common than aseptic loosening (37.4%) in second or subsequent revisions.

Conclusion

Aseptic loosening and infection remain the most common causes of revision THAs at our center. Although the proportion of infections has decreased in the recent decade, a national database is necessary for a more comprehensive understanding of the causes of revision THAs in China. This work provides an understanding and comparison of the causes of revision THA in an orthopedic center among the Chinese population. This may reveal a potential change in revision THAs causes in the future, reminding surgeons to find a proper way to treat them.

Introduction

Total hip arthroplasty (THA) is one of the most successful orthopedic surgeries performed in recent decades [1]. The literature reports that primary THA has a survival rate of over 90% at a 10-year follow-up [2–7]. With improvements in surgical techniques and implant design, surgeons have reported the survival of hip implants even after 20 years of follow-up [5, 8, 9]. However, an increased number of primary THAs is associated with more revision THA cases. Surgeons must aim to improve the functionality and longevity of primary THA, as the survivorship after revision surgery is poorer than that after primary THA surgery [10, 11]. THA failure brings physical and fiscal burdens to patients and depletes limited medical

resources. Failure causes include infection, periprosthetic fracture, implant loosening, instability, and adverse local tissue reaction. Many developed countries have already established arthroplasty registration centers, and have published large studies on arthroplasty [12–15]. In 1979, the Swedish Hip Arthroplasty Register (SHAR) was established to study revision procedures [12]. Cnudde et al. [12] reported that the proportion of all-cemented implants decreased from 92% in 1999 to 68% in 2012. In 2019, Cnudde et al. [16] retrospectively analyzed 9,926 patients from the SHAR who underwent revision THA and reported aseptic loosening as the leading cause of failure, followed by infection, periprosthetic fracture, and instability (3558, 2065, 1574, and 1782 cases, respectively). These data are of great benefit in improving patient clinical outcomes. However, the revision THA epidemiology in China remains unclear. Hip arthroplasty was introduced in China in the 1990s, and our institution established an arthroplasty registration center in 1997. In this study, we aim to analyze revision THA causes in a large center in China over a period of 20 years and determine potential changes in revisions reasons in the future.

Materials And Methods

Ethical approval

This study complies with the Declaration of Helsinki and its later amendments. The institution's medical ethics committee approved the study, and because all data assessed were routinely obtained in this department at the time of the study and because no additional investigations or procedures were performed, informed consent was not required.

Study design

We retrospectively reviewed the records of 1,353 revision THAs performed in our department from January 1999 to December 2018, as recorded at the institution's arthroplasty registration center. We documented patient's basic data (including age, sex, height, and weight), revision THA date, and failure mechanisms. We grouped the causes of revision THA into six categories: aseptic loosening, osteolysis (no loosening), infection (two-stage surgery was recorded as one item), instability, periprosthetic fracture, and others. We grouped patients based on their revision THA surgery date, counted the number of revision THAs, and analyzed revision causes. Patients were stratified into 2 groups: the early decade group, with a revision date from January 1999 to December 2008, and the late decade group, with a revision date from January 2009 to December 2018. We also divided patients into two groups according to whether they were younger than 60 years, or aged 60 years and above, at the time of surgery, and compared the differences in revision causes. We counted the causes of first, second, and third or subsequent revisions.

Statistical analysis

Continuous data were tested for normality using the Kolmogorov-Smirnov test. Normally distributed data were presented as mean standard deviation, and analyzed using the Student's *t*-test. Non-normally distributed data were presented as median (range) and analyzed using the nonparametric Mann-Whitney

U test. Categorical variables were presented as frequencies and analyzed using the Fisher's exact test. All data were analyzed using SPSS (version 21.0; IBM SPSS, Chicago, IL, USA) software. A P-value of more than 0.05 was considered statistically significant.

Results

The total samples in the analysis included 1,353 revision THA procedures in patients with a mean age of 60.4 ± 12.3 years (range, 23-89 years) who attended our institution from January 1999 to December 2018. Their mean height and weight were 165.1 ± 7.9 cm (range, 143 to 185 cm) and 66.8 ± 12.2 kg (range, 38 to 105 kg), respectively, and mean body mass index (BMI) was 24.4 ± 3.6 kg/m² (range, 14.3 to 37.6 kg/m²). All performed surgeries were posterolateral. Of the 1,353 hips, 659 (48.7%) were in female and 694 (51.3 %) were in male patients. There were 708 (52.3%) left hips and 645 (47.7%) right hips.

Table 1. Patient demographics

	Number of patients (total percentage) [total =1353 hips]
Male	694 (51.3%)
Female	659 (48.7%)
Left	708 (52.3%)
Right	645 (47.7%)
Year of revision	396 (29.3%)
1999-2008	
2009-2018	957 (70.7%)
Age at revision (years)	
<60	573 (42.4%)
≥60	780 (57.6%)
Number of revision surgeries	
First revision	1190 (88.0%)
Second revision	142 (10.5%)
Third or subsequent revision	21 (1.5%)

Of the total revisions performed, 826 (61.0%) were for aseptic loosening; 235 (17.3%) for periprosthetic infection, 151 (11.2%) for other reasons, including adverse local tissue reaction, implant fracture, shedding or rupture of bearings, leg length discrepancy, soft tissue stimulation, and non-union of the osteotomy, 61 (4.5%) for periprosthetic fracture, 52 (3.8%) for osteolysis (no loosening), and 28 (2.1%) for instability.

Table 2. Causes of revision total hip arthroplasty

	Number of patients (total percentage) [total = 1353 revisions]
Aseptic loosening	826 (61.0%)
Prosthetic joint infection	151 (11.2%)
Periprosthetic fracture	61 (4.5%)
Osteolysis (no loosening)	52 (3.8%)
Instability	28 (2.1%)
Failure of femoral head replacement	22 (1.6%)
Implant fracture	8 (0.6%)
Shedding or rupture of bearings	6 (0.4%)
Adverse local tissue reaction/ adverse reaction to metal debris	6 (0.4%)
Others (soft tissue stimulation/leg length discrepancy/non-union of the osteotomy/implant malposition, etc.)	109 (8.1%)

The leading causes of revision were aseptic loosening and infection, totaling 1,061 cases (78.4%), and aseptic loosening was approximately 3.5 times more common than infection.

The number of hip revision surgeries in our institution increased dynamically. There were 396 and 957 cases in the early decade (from January 1999 to December 2008), and late decade (from January 2009 to December 2018) groups, respectively, indicating a 2.4-fold increase. In the early and late decade groups, the mean age of patients was 59.7 ± 12.0 years and 60.7 ± 12.4 years ($p = 0.19$), respectively, and the mean BMI was 24.5 ± 3.6 kg/m² and 24.4 ± 3.6 kg/m² ($p = 0.48$), respectively, with no significant difference. The proportion of revisions due to infection was lower and that of aseptic loosening, periprosthetic fracture, dislocation, and osteolysis was higher in the late decade group than that in the early decade group.

We divided patients into two groups according to their age. In patients aged less than 60 years, 573 revision THAs were performed, and in those aged 60 years or more, 780 revision THAs were performed. The proportion of revisions was 21.9% for infection and 58.1% for aseptic loosening in patients aged less than 60 years, and 13.9% for infection and 63.4% for aseptic loosening in patients aged 60 years or more.

Table 4. Causes of revisions in the different age groups

	Total percentage (%)	
	<60 years (total = 573 hips)	≥60 years (total = 780 hips)
Aseptic loosening	58.10	63.40
Infection	21.90	13.90
Osteolysis (no loosening)	4.40	3.50
Instability	0.50	3.10
Periprosthetic fracture	3.50	5.30
Others	11.60	10.80

The rate of revisions was higher in younger patients due to infection, whereas it was higher in older patients due to aseptic loosening, periprosthetic fracture, and instability.

In the 1,353 patients, 1,190 cases underwent primary revision, 142 cases underwent second revision, and 21 cases were revised for the third or subsequent time. Infection (52.1%), aseptic loosening (38.7%), and periprosthetic fracture (2.1 %) were the most common causes for second revisions, and infection (57.1%) and aseptic loosening (28.6%) were the most common causes for third or subsequent revisions (Figure 1). Two patients underwent sixth and eighth revisions each for infections.

Discussion

Aseptic loosening and infection are the most common causes for revision THAs. Revision due to fracture and instability were much less common in our center. Studies from Finland, Sweden, and the United States [15,17-19] have reported aseptic loosening as the leading reason for revision. With improved tribology and surface coating techniques, the proportion of aseptic loosening in revision THAs is decreasing in western countries. Clohisy et al. [20] and Ulrich et al. [19] reported data from their respective centers in 2004 and 2008, respectively, where the proportion of aseptic loosening in revision THAs was 55% and 52%, respectively. In 2016, Haynes et al. [21] showed that aseptic loosening only accounted for 31.3% of hip revision cases. In our center, revisions due to aseptic loosening have increased over the last 20 years. Total hip arthroplasty was performed in the late 1990s in our country. Poor surgical techniques and improper implant selection were the main reasons for aseptic loosening. Clohisy et al. [22] reported that cemented prostheses had a higher rate of loosening than uncemented prostheses, indicating the importance of cementing surgical techniques and implant design [23-25]. For the bearing surface, the early design of non-crosslinked polyethylene had higher wear and revision rates [26,27]. Surgeons should attempt to increase the durability of primary arthroplasty by improving their surgical techniques and selecting a well-documented prosthesis for their patients.

Infection and instability are significant complications that lead to revision, mainly noted in the early postoperative period. The proportion of revisions for infection has decreased in 10 years, between 2009 and 2019, at other centers. Lachiewicz et al. [28] published a retrospective review of two cohorts of 100 consecutive revisions performed 10 years apart by one surgeon. For the early cohort, the indications for infection were 10% compared with 7% in the recent cohort. However, the proportion of infection-related revisions was 17.3% in the present study, which is higher than that seen in other studies [21]. There was a selection bias in our center, as doctors in rural areas may miss the treatment window for debridement and prosthesis retention when facing acute peri-prosthetic infection. Patients were referred to our hospital when infection was chronic with persistent pain or sinus formation. A two-stage revision was the treatment of choice for chronic infection. Peri-prosthetic infection was difficult to manage, with high chances of re-revision. This was demonstrated in our study by the observed high chances of infection in revision cases. Doctors should avoid delaying an acute infection until it becomes chronic by treating patients following the Musculoskeletal Infection Society guidelines [29]. We expect a decrease in infections due to improved prophylaxis for periprosthetic joint infection and delicate surgical manipulation [30].

We found that infection and aseptic loosening were the most common reasons for multiple revisions, indicating treatment difficulties in facing these types of failures. Jafari et al. [31] analyzed 1,366 revision THAs and reported that 256 of these revisions failed, mainly due to infection (30.2%), instability (25.1%), and aseptic loosening (19.4%), with an average time to failure of 16.6 months. Springer et al. [32] reported that the most common reasons for failure in 141 patients requiring a second revision were instability (35%), aseptic loosening (30%), and infection (12%). Interestingly, we had limited cases of revisions for instability. Surgical approach and surgeon experience may affect THA stability [33]. Our proportion of THA failure due to instability was lower than that in the reports from the United States. Bozic et al. [34] published a retrospective study using the Healthcare Cost and Utilization Project Nationwide Inpatient Sample database, which included 51,345 revision THA cases from October 2005 to December 2006. The results showed that the most common causes of revision were instability/dislocation (22.5%), mechanical loosening (19.7%), and infection (14.8%). Gwam et al. [35] used the National Inpatient Sample database to identify all revision THA procedures performed in the 5 years between January 2009 and December 2013. They also discovered that the most common indications for revision THA in the United States were dislocation (17.3%) and mechanical loosening (16.8%). However, there was a lower instability-induced revision incidence in the present study, which may be explained by the following two reasons: intraoperatively, when facing hip instabilities, surgeons tend to increase soft tissue tension by increasing leg length or offset, and postoperatively, stricter and longer posture protection contributes to reducing joint dislocation rate. These management techniques sacrifice the hip range of motion, thus helping reduce hip dislocation chances. However, when patients have less range of motion in the hip, they have to compensate by recruiting more spine motion for daily activities, leading to more lumbar pain [36]. The high proportion of hip revisions due to instability in the United States reminds surgeons to modify their practice to provide high-quality medical services, such as using a direct anterior approach for faster postoperative rehabilitation [37]. Furthermore, patients may benefit

from the use of larger femoral head sizes, elevated or lipped liners, high-offset femoral stems, and dual mobility implants to improve hip stability and maintain an adequate range of motion.

As our hospital is located in a city center, transportation remains a challenge for patients with periprosthetic fractures; therefore, the number of patients with periprosthetic fractures is relatively low in the present study. Zheng et al. [38] reviewed patients with Vancouver type B peri-prosthetic fractures in two departments of a single, large hospital in China from 2008 to 2016. The results showed that all fractures healed in the surgical treatment group. Internal fixation for B2 and B3 fractures requires more prolonged healing and has relatively poorer mobility postoperatively than revision THA.

The present study revealed a higher rate of revisions due to infection among patients aged less than 60 years and higher proportions of aseptic loosening, periprosthetic fracture, and instability among those aged 60 years or more. The characteristics of each disease entity may explain this finding. Older patients experience more aseptic loosening, which is a long-term postoperative complication. Infection may occur at any time postoperatively, primarily in the early postoperative period. Cnudde et al. [13] reported that reoperation in the early postoperative period (90 days) was primarily due to infection or dislocation, according to SHAR.

Our study has several limitations. First, this was a retrospective study; therefore, we were limited to evaluating data that have already been collected. We were unable to identify the details of each failure mode, and the limited level of knowledge of the disease at the time of surgery may have caused misdiagnoses or underdiagnoses. We attempted to find all possible data to minimize this limitation. Furthermore, some revision surgery details were not compared due to the heterogeneity of revision surgeries, and the authors did not evaluate the survivorship of these revision surgeries. These theoretical assumptions should be proven in future clinical studies. Second, as this was a single-center study, we used the institutional database, which only included patients who were treated at our center. This may have caused a selection bias and may not represent revision THA prevalence in a wider area. A local or national database will be necessary for more precise information and to obtain a comprehensive understanding of the national situation regarding THA. Third, data on cases of infection did not provide a distinction between those that occurred in those with one-stage and two-stage surgery. Fourth, as many patients underwent primary THA in other institutions, we were unable to obtain all information regarding patients' index procedures. The establishment of a national arthroplasty registration database will help solve this problem. Further efforts are necessary to improve the details of each revision case to obtain more in-depth research results.

Conclusions

THA failure is problematic for surgeons and patients alike. This study currently has the largest sample study volume in a developing country. We discovered that aseptic loosening and infection were the most common reasons for THA revision. The increasing cases of instability in other countries remind us that appropriate management is essential to reduce dislocation risks. Assessment of causes of failure after

THA provide valuable data for the government and manufacturers to guide prosthesis design, improve surgical techniques, and change the clinical outcomes, and this may even provide a basis for the formulation of relevant national policies.

List Of Abbreviations

THA, Total hip arthroplasty; SHAR, Swedish Hip Arthroplasty; BMI, body mass index;

Declarations

Ethics approval and consent to participate:

This retrospective study was approved by the Beijing Jishuitan Hospital Institutional Review Board (Beijing Jishuitan Hospital Institutional Review Board Approval Form 202008-02). All activities associated with this research project were performed in accordance with Jishuitan Hospital Institutional Guidelines and Clinical Regulations. Because all data assessed were routinely obtained in this department at the time of the study and because no additional investigations or procedures were performed, informed consent was not required.

Consent for publication:

Not applicable.

Availability of data and materials:

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

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

JG and XF drafted the manuscript, JG collected and analyzed the data, JG, HS and YZ made contribution to the conception and design of this study. All authors read and approved the final manuscript.

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Figures

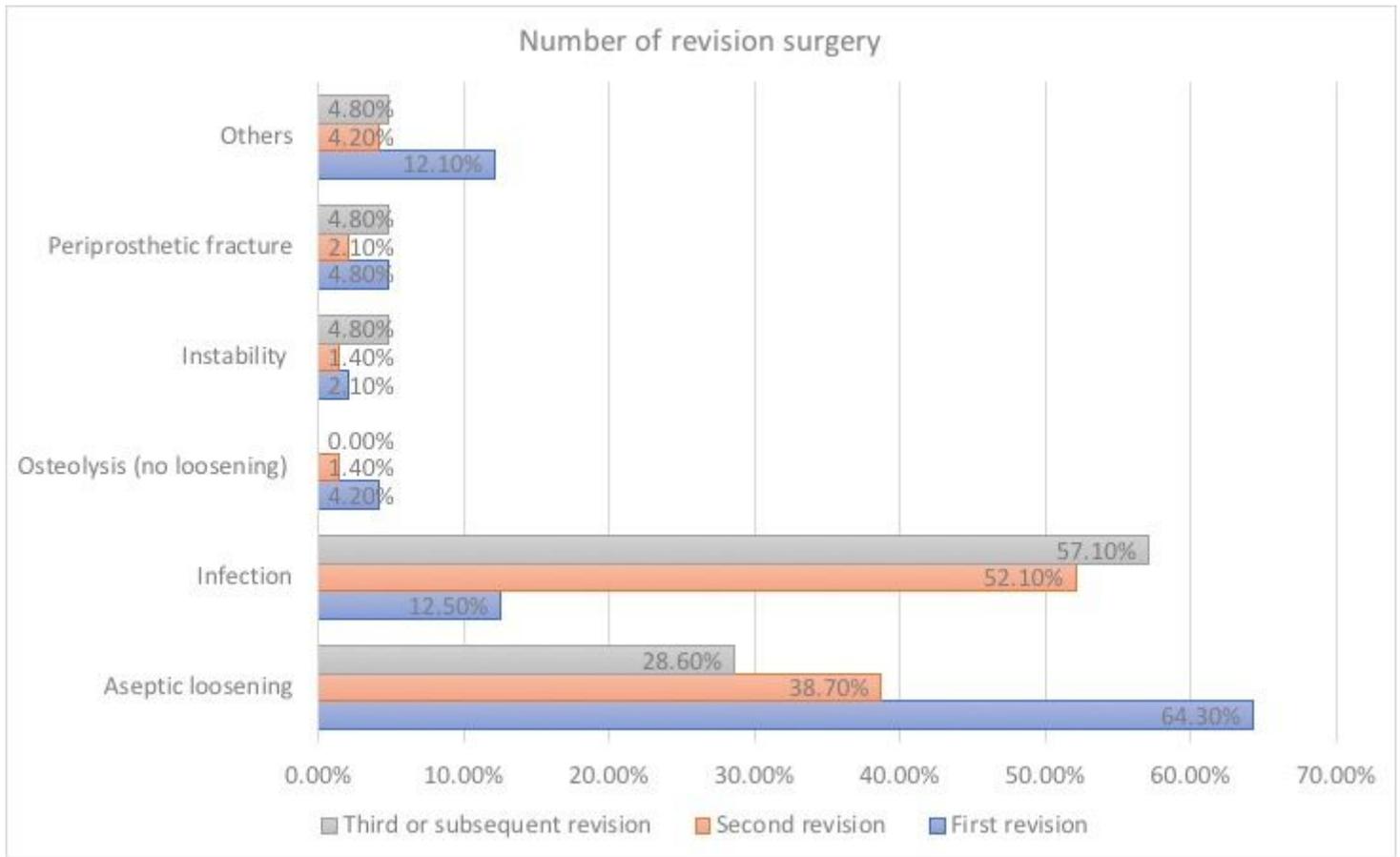


Figure 1

Causes of first, second, and third or subsequent revisions. The proportion of reasons for revision are shown for each group. The proportion of infections increased, and aseptic loosening decreased as the times of revision increased.