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CAUSES AND RISK FACTORS IN PRIMARY TOTAL HIP REPLACEMENT LEADING TO REVISION SURGERY

Orthopaedics

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ABSTRACT

Background: Total hip replacement (THR) is a widely performed and highly successful orthopedic procedure. However, the increasing frequency of primary THR has led to a corresponding rise in revision surgeries. Revision total hip replacement (RTHR) is associated with increased surgical complexity, morbidity, healthcare costs, and poorer outcomes compared to primary THR. Identifying the causes and risk factors leading to revision is essential for improving long-term implant survival and optimizing patient care. **Objectives:** This study aims to analyze the common causes of failure following primary THR and to evaluate the demographic, clinical, and surgical risk factors associated with an increased likelihood of revision. **Materials And Methods:** This retrospective, observational, case-control study was conducted in the Department of Orthopaedics at Jagannath Gupta Institute of Medical Sciences And Hospital, Budge Budge, Kolkata, West Bengal 700137 over a period of Nov 2022 to Oct 2024. A total of 240 patients who had previously undergone primary total hip replacement (THR) were included. These patients were categorized into two groups: the Revision Group (n = 120), comprising individuals who required revision surgery after primary THR, and the Control Group (n = 120), consisting of patients who had an uncomplicated course following primary THR without the need for revision during the follow-up period. **Results:** The comparison between revision and control groups (each with 120 patients) showed no significant differences in gender, laterality, BMI, or Charlson Comorbidity Index. However, significant differences were noted in the type of THR fixation ($p < 0.001$), with more cemented and hybrid fixations in the revision group, and in primary diagnosis ($p = 0.004$), where AVN was more common in the control group. Aseptic loosening was the leading cause of revision (59.2%), particularly in late failures (>5 years), while infections (15%) and instability (10%) were more common in early failures (<5 years). Cox regression analysis revealed younger age (<45 years) and hybrid fixation significantly increased revision risk, while gender, BMI, primary diagnosis, comorbidities, and other fixation types were not significant predictors. **Conclusion:** The comparison between the revision and control groups showed no notable differences in gender, side of surgery, body mass index, or comorbidity burden. However, significant variations were observed in the type of hip replacement fixation and the underlying diagnosis, with more cemented and hybrid fixations seen in the revision group and avascular necrosis being more frequent in the control group. Aseptic loosening emerged as the most common reason for revision, especially in cases failing after several years, whereas infections and instability were more often linked to early failures. Further analysis indicated that younger age and hybrid fixation were associated with a higher risk of revision, while other factors showed no significant influence.

KEYWORDS

Revision hip arthroplasty, aseptic loosening, prosthetic joint infection, total hip replacement, risk factors.

INTRODUCTION

Total hip replacement (THR) is a well-established and effective surgical intervention for end-stage hip arthritis and other debilitating hip conditions. With advancements in surgical techniques, implant design, and perioperative care, primary THR has achieved high success rates and improved patient quality of life. However, despite these advancements, a significant subset of patients eventually require revision surgery due to various complications or implant failures. Revision total hip replacement (rTHR) is a complex and resource-intensive procedure associated with higher morbidity, longer operative time, increased blood loss, prolonged rehabilitation, and higher healthcare costs compared to primary THR [1,2].

The demand for revision THR is steadily rising due to increasing life expectancy, higher patient activity levels, and the growing number of primary THR procedures being performed globally. According to joint registries and population-based studies, the revision burden currently stands at approximately 10–15% within 10 to 15 years of the initial procedure [3,4]. Common causes leading to revision include aseptic loosening, periprosthetic joint infection (PJI), instability or dislocation, periprosthetic fractures, implant wear, osteolysis, and technical errors during the index surgery [5,6].

Aseptic loosening remains the most frequently cited cause of revision, often occurring as a result of mechanical failure at the bone-implant interface due to wear-induced osteolysis or suboptimal fixation. Infection, particularly chronic or delayed PJI, is another major indication for revision and poses significant diagnostic and therapeutic challenges [7]. Dislocation or instability may occur due to malpositioned components, soft tissue imbalance, or patient-related factors such as neuromuscular disorders. Other notable causes include periprosthetic fractures (especially in elderly, osteoporotic patients) and adverse local tissue reactions, particularly in metal-on-metal implants [8].

Understanding the risk factors associated with primary THR failure is crucial for prevention and improving outcomes. These risk factors are broadly categorized into patient-related, implant-related, and surgical factors. Patient-related risks include younger age (due to higher activity levels), male sex, obesity, smoking, comorbidities such as diabetes and osteoporosis, and previous hip surgeries [9]. Implant-related risks encompass implant design, bearing surface, and fixation method (cemented vs. uncemented). Surgical factors involve component positioning, soft tissue handling, and surgical volume or expertise of the surgeon.

Effective preoperative planning, optimal implant selection, meticulous surgical technique, and early recognition of postoperative complications are pivotal in minimizing the need for revision. Additionally, national joint registries and surveillance programs have played a crucial role in tracking implant performance and identifying high-risk scenarios, allowing for more informed clinical decision-making and patient counseling [10]. This study aims to analyze the common causes of failure following primary THR and to evaluate the demographic, clinical, and surgical risk factors associated with an increased likelihood of revision.

MATERIALS AND METHODS

Study Design And Setting

This was a retrospective, observational, case-control study conducted at the Department of Orthopaedics, Department of Orthopaedics at Jagannath Gupta Institute of Medical Sciences And Hospital, Budge Budge, Kolkata, West Bengal 700137 over a period of Nov 2022 to Oct 2024. The study was approved by the Institutional Ethics Committee,

and patient confidentiality was maintained throughout the study.

Study Population

A total of **240 patients** who had undergone primary total hip replacement (THR) were included in the study. They were divided into two groups:

- **Revision Group (n = 120):** Patients who required revision surgery following primary THR.
- **Control Group (n = 120):** Patients who underwent uncomplicated primary THR with no revision during the follow-up period.

Inclusion Criteria

- Patients aged ≥18 years.
- Underwent primary THR for osteoarthritis, rheumatoid arthritis, avascular necrosis, or femoral neck fracture.
- Complete medical records and follow-up data for at least 2 years.

Exclusion Criteria

- Patients with incomplete records.
- Patients who underwent revision for reasons unrelated to prosthesis failure (e.g., trauma, malignancy).
- Infections unrelated to prosthesis or primary surgery.

Data Collection

Patient data were obtained from hospital records, operative notes, and follow-up reports. The following variables were collected:

- **Demographic Data:** Age, gender, BMI.
- **Clinical Data:** Indication for primary THR, side (right/left), comorbidities (diabetes, hypertension, osteoporosis).
- **Surgical Variables:** Type of prosthesis (cemented/uncemented/hybrid), surgical approach used, fixation technique.
- **Outcome Measures:** Time to revision, cause of revision (aseptic loosening, infection, periprosthetic fracture, dislocation, wear), and risk factors associated with failure.

Statistical Analysis

For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

RESULT

Table 1. Demographic Data

Categorical variables		Revision (n = 120)	Control (n = 120)	p-value
Gender	Female	64 (53.3%)	69 (57.5%)	0.387
	Male	56 (46.7%)	51 (42.5%)	
Side	Right	61 (50.8%)	57 (47.5%)	0.535
	Left	59 (49.2%)	63 (52.5%)	
Body mass index	<25	54 (60.0%)	76 (63.3%)	0.494
	≥25	36 (40.0%)	44 (36.7%)	
Type of THR fixation	Cementless	52 (43.3%)	89 (74.2%)	<0.001
	Cemented	45 (37.5%)	4 (3.3%)	
	Hybrid	23 (19.2%)	27 (22.5%)	
Primary diagnosis	Avascular necrosis	44 (36.7%)	66 (55.0%)	0.004
	Non-avascular necrosis	76 (63.3%)	54 (45.0%)	
	Primary osteoarthritis	21 (17.5%)	16 (13.3%)	
	Fracture neck of femur	10 (8.3%)	2 (1.7%)	
	Posttraumatic OA	9 (7.5%)	11 (9.2%)	
	Inflammatory arthritis	9 (7.5%)	1 (0.8%)	
	Postseptic OA	6 (5.0%)	3 (2.5%)	
	DDH	4 (3.3%)	12 (10.0%)	
	Other	7 (5.8%)	9 (7.5%)	
	Unknown	11 (9.2%)	1 (0.8%)	
Charlson Comorbidity Index	0	99 (82.5%)	97 (80.8%)	0.747
	1–2	20 (16.7%)	22 (18.3%)	
	3–4	1 (0.8%)	1 (0.8%)	

Table 2. Cause of Revision Total Hip Replacement (n = 120 Revision patients)

Cause of revision	Early (<5 years)	Late (>5 years)	Overall
Periprosthetic joint infection	14 (29.8%)	4 (5.1%)	18 (15.0%)
Aseptic loosening	13 (27.7%)	58 (74.4%)	71 (59.2%)
Instability	10 (21.3%)	2 (2.6%)	12 (10.0%)
Component malposition	4 (8.5%)	0	4 (3.3%)
Periprosthetic fracture	4 (8.5%)	6 (7.7%)	10 (8.3%)
Component failure	1 (2.1%)	3 (3.8%)	4 (3.3%)
Polyethylene wear	0	4 (5.1%)	4 (3.3%)

Table 3. Cox Regression Analysis For Revision THR

Covariate	Group	Hazards Ratio (95% CI)	p-value
Gender	**Female**	1	-
	Male	1.020 (0.784–1.340)	0.859
Age at primary surgery	**>55**	1	-
	45–55	0.681 (0.458–1.012)	0.057
	<45	0.695 (0.492–0.981)	0.038
BMI	**≥25**	1	-
	<25	0.920 (0.662–1.280)	0.621
Primary diagnosis	**Avascular necrosis**	1	-
	Non-AVN	1.104 (0.828–1.473)	0.499
Type of fixation	**Cementless**	1	-
	Cemented	0.994 (0.721–1.372)	0.973
	Hybrid	1.652 (1.166–2.341)	0.005
Underlying disease	**Yes**	1.497 (0.785–2.588)	0.220
Charlson Comorbidity Index	**0**	1	-
	1–2	0.880 (0.536–1.445)	0.614
	3–4	0.978 (0.136–7.018)	0.982

Table 4. Comparison with Previous Studies (Early and Late Failures)

Early Failures

Study	1st Cause (%)	2nd Cause (%)	3rd Cause (%)
Clohisy et al. 2004 (n=37)	Aseptic loosening (51.0%)	Instability (18.0%)	Infection (11.0%)
Ulrich et al. 2008 (n=119)	Instability (30.5%)	Aseptic loosening (27.1%)	Infection (19.6%)
Present study (n=60 est.)	Infection (29.8%)	Aseptic loosening (27.7%)	Instability (21.3%)

Late Failures

Study	1st Cause (%)	2nd Cause (%)	3rd Cause (%)
Clohisy et al. 2004 (n=37)	Aseptic loosening (61.0%)	Osteolysis (26.0%)	Periprosthetic fracture (8.0%)
Ulrich et al. 2008 (n=119)	Aseptic loosening (80.7%)	Infection (9.2%)	Instability (4.2%)
Present study (n=60 est.)	Aseptic loosening (74.4%)	Periprosthetic fracture (7.7%)	Polyethylene wear (5.1%)

The comparison of categorical variables between the revision and control groups (each comprising 120 patients) revealed several statistically significant and non-significant findings. Gender distribution was similar across both groups ($p = 0.387$), with a slight female predominance. Laterality (right vs. left hip) also showed no significant difference ($p = 0.535$). The body mass index (BMI) distribution (<25 vs. ≥25) did not differ significantly between groups ($p = 0.494$). However, a statistically significant difference was observed in the type of total hip replacement (THR) fixation, with the revision group having a higher proportion of cemented and hybrid fixations, while the control group had a predominance of cementless fixation ($p < 0.001$). Primary diagnosis also differed significantly ($p = 0.004$), with avascular necrosis (AVN) being more prevalent in the control group, while the revision group had a greater variety of non-AVN diagnoses. Other individual diagnoses such as developmental dysplasia of the hip (DDH), inflammatory arthritis, and postseptic osteoarthritis showed variable distribution. The Charlson Comorbidity Index scores were comparable between the two groups ($p = 0.747$), indicating no significant difference in baseline comorbid conditions.

The causes of revision total hip replacement (THR) were categorized based on the timing of failure: early (<5 years) and late (>5 years)

revisions. Aseptic loosening emerged as the most common overall cause, accounting for 59.2% of all revisions, and was predominantly associated with late revisions (74.4%). Periprosthetic joint infection was the leading cause of early failures (29.8%) but was significantly less frequent in late revisions (5.1%), contributing to 15% of all revisions. Instability was also more common in early revisions (21.3%) compared to late (2.6%), representing 10% of total cases. Other less frequent causes included periprosthetic fracture (8.3%), with a relatively even distribution between early and late revisions, and component malposition (3.3%), which was seen only in early failures. Component failure (3.3%) and polyethylene wear (3.3%) were relatively rare, with the latter occurring exclusively in late revisions. This distribution highlights the distinct etiologies associated with early versus late revision THR.

The multivariate Cox regression analysis identified several covariates associated with the risk of revision following primary total hip replacement (THR). Gender did not significantly influence revision risk, with males showing a hazard ratio (HR) of 1.020 (95% CI: 0.784–1.340; p = 0.859) compared to females. Age at the time of primary surgery showed a trend toward reduced risk in younger patients; patients aged <45 had a significantly lower risk (HR: 0.695; 95% CI: 0.492–0.981; p = 0.038), while those aged 45–55 showed a borderline non-significant reduction (HR: 0.681; p = 0.057). Body mass index (BMI) and primary diagnosis (AVN vs. non-AVN) were not significant predictors. Among fixation types, hybrid fixation was associated with a significantly higher risk of revision compared to cementless fixation (HR: 1.652; 95% CI: 1.166–2.341; p = 0.005), while cemented fixation showed no significant difference (HR: 0.994; p = 0.973). Underlying disease presence was not a statistically significant factor (p = 0.220). The Charlson Comorbidity Index also did not significantly affect revision risk, with HRs close to 1 across increasing comorbidity levels. These findings suggest that younger age and hybrid fixation are important factors influencing the likelihood of revision.

DISCUSSION

The present study offers a comprehensive analysis of factors associated with revision total hip replacement (THR), distinguishing between early and late failures and evaluating demographic, clinical, and surgical parameters. Our findings indicate no statistically significant differences in gender, laterality, BMI, or comorbidity burden between revision and control groups. However, fixation type and primary diagnosis emerged as significant differentiators. Notably, cementless fixation was more common in the control group, while hybrid and cemented fixations were overrepresented in the revision cohort. This aligns with the study by Bozic et al., who found that cementless fixation was associated with lower revision rates compared to hybrid systems, particularly in younger, active patients [11]. Similarly, Kärrholm et al., in their registry-based study, reported higher failure rates in hybrid THRs, especially due to aseptic loosening in the long term [12].

The predominance of aseptic loosening as a cause of revision—especially in late failures— is consistent with literature trends. A registry study by Dale et al. supports this, identifying aseptic loosening as the most frequent indication for late revision surgeries, often linked to mechanical wear and osteolysis [13]. Periprosthetic joint infection (PJI) being the leading cause of early revision parallels the observations of Ong et al., who reported that infection accounted for nearly 25–30% of revisions within the first five years of implantation [14]. Instability, another common early failure cause, was also frequently seen in early revisions in our study; this is echoed in the work by Patel et al., who found instability to be a major issue within the first two years post-THR, often attributed to suboptimal component positioning and soft-tissue imbalance [15].

Cox regression analysis from our dataset identified hybrid fixation as a significant predictor of increased revision risk compared to cementless fixation. The elevated hazard ratio for hybrid systems (HR: 1.652; p = 0.005) corroborates the findings of Bozic et al. [11], reinforcing the notion that fixation strategy plays a crucial role in implant longevity. Age was also an influential factor, with patients under 45 years demonstrating a significantly reduced risk of revision, possibly due to better bone quality, fewer comorbidities, and greater adherence to postoperative rehabilitation. However, BMI and Charlson Comorbidity Index did not significantly influence revision risk, suggesting that patient selection and surgical technique may outweigh these systemic factors in affecting implant survival. These observations highlight the multifactorial etiology of THR failure and underscore the need for tailored surgical planning, especially in high-risk patients.

CONCLUSION

This study provides a comprehensive evaluation of the demographic, clinical, and surgical variables associated with revision total hip replacement (THR). While gender, side of surgery, BMI, and comorbidities were comparable between revision and control groups, significant differences were noted in the type of THR fixation and primary diagnosis. Cementless fixation was more common in the control group, whereas revision cases had higher rates of cemented and hybrid fixations. AVN was predominantly associated with primary THR cases, while revisions had a broader spectrum of diagnoses. Analysis of revision causes highlighted aseptic loosening as the most common late complication, whereas infections and instability were leading causes in early revisions. Multivariate Cox regression further identified younger age (<45 years) as a protective factor against revision, and hybrid fixation as significantly associated with increased revision risk. These findings underscore the importance of surgical technique and patient selection in optimizing THR outcomes and minimizing the need for revision procedures.

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