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Identification of Risk Factors for Infection Following Total Hip Arthroplasty

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A B S T R A C T

Introduction: Periprosthetic joint infection (PJI) is a serious complication following total hip arthroplasty (THA), associated with significant morbidity, healthcare costs, and revision surgery. Identifying patient-related and perioperative risk factors is essential to improve outcomes and guide preventive strategies.

Materials and Methods: This retrospective cohort study included 100 patients who underwent primary THA at Tabriz University of Medical Sciences between January 2019 and December 2023. Demographic, clinical, intraoperative, and postoperative variables were collected. PJI diagnosis was based on Musculoskeletal Infection Society (MSIS) criteria. Univariate and multivariate logistic regression analyses were performed to identify independent risk factors.

Results: The incidence of PJI was 7%. Multivariate analysis identified obesity (BMI >30), diabetes mellitus, smoking history, prolonged operative time (>100 minutes), and blood transfusion as independent predictors of PJI ($p < 0.05$ for all). Other factors such as use of drains and urinary catheters showed significance in univariate analysis.

Conclusion: PJI after THA is significantly influenced by modifiable risk factors. Optimizing patient comorbidities, minimizing surgical time, and implementing targeted perioperative strategies may reduce infection rates. Further multicenter studies are warranted to validate these findings.

Introduction

Total hip arthroplasty (THA) stands as one of the most successful and frequently performed orthopedic procedures worldwide [1]. Over the past few decades, advances in surgical technique, implant technology, and perioperative care have dramatically improved patient outcomes [2], offering substantial pain relief and restored mobility for individuals suffering from debilitating hip joint disorders such as osteoarthritis, rheumatoid arthritis, avascular necrosis, and fractures [3].

Despite its overall efficacy and safety profile, THA is not without complications. Among the most serious and challenging of these is periprosthetic joint infection (PJI), a complication that, although relatively infrequent, carries significant morbidity and economic burden [4].

Periprosthetic joint infection is a complex and multifactorial condition that can compromise the long-term success of the arthroplasty.

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It often necessitates extensive treatment involving surgical debridement, prolonged antibiotic therapy, and, in severe cases, revision surgery or even removal of the prosthesis [5]. These interventions are associated with increased healthcare costs, extended hospital stays, reduced functional outcomes, and considerable psychological distress for patients [6].

The implications of infection extend beyond clinical outcomes, placing a substantial strain on healthcare systems due to the complexity of care and the resources required for management. Consequently, preventing PJI has become a central focus in orthopedic practice and research [7].

The development of infection following THA is influenced by a wide range of factors that span the preoperative, intraoperative, and postoperative periods. These risk factors can be broadly categorized into patient-related variables, surgical factors, and postoperative management considerations [8].

Patient-related risk factors include underlying medical conditions such as diabetes mellitus, obesity, immunosuppression, malnutrition, and poor glycemic control, all of which are known to compromise immune function and wound healing. Age, smoking status, and colonization with drug-resistant organisms, such as methicillin-resistant *Staphylococcus aureus* (MRSA), further compound the risk. Each of these factors, whether modifiable or non-modifiable, plays a critical role in determining an individual's susceptibility to infection [9-11].

Intraoperative variables also contribute significantly to infection risk. Extended operative times, increased blood loss, and breaches in sterile technique are associated with heightened vulnerability to bacterial contamination [12].

Additionally, the complexity of the procedure—whether it is a primary or revision arthroplasty—impacts the likelihood of infection, with revision surgeries generally carrying a greater risk due to scar tissue, altered anatomy, and previous exposure to implants [13]. The surgical environment itself, including the use of laminar airflow systems and adherence to antibiotic prophylaxis protocols, also influences infection rates. As such, optimizing intraoperative practices remains a key component of infection prevention strategies [14].

Postoperative care continues to play a vital role in minimizing the risk of PJI. Factors such as wound complications, hematoma formation, and the use of indwelling devices like urinary catheters and surgical drains can increase the chances of microbial colonization and subsequent infection [15]. Moreover, early detection and prompt management of superficial infections are crucial in preventing progression to deeper, more serious infections involving the prosthetic joint. Patient education, close monitoring, and coordinated multidisciplinary follow-up are essential elements of effective postoperative care [16].

The ability to accurately identify and address risk factors for infection is essential for tailoring preventive measures and optimizing surgical outcomes [17]. While advances in technology and technique have contributed to reducing infection rates, the persistence of PJI highlights the need for continuous improvement in risk assessment and prevention protocols [18]. Individualized patient optimization before surgery, strict adherence to evidence-based surgical practices, and vigilant postoperative monitoring are all integral to reducing the incidence of this severe complication [19].

Given the significant clinical and economic consequences associated with PJI, research into the identification and mitigation of risk factors is critical. A thorough understanding of the multifaceted nature of infection development is essential not only for improving patient outcomes but also for informing policy, guiding clinical decision-making, and allocating healthcare resources efficiently. The present study aims to investigate and evaluate the various risk factors associated with infection following total hip arthroplasty, with a focus on identifying modifiable variables that can be targeted for intervention. By elucidating these factors, this research seeks to contribute to the growing body of knowledge aimed at enhancing the safety and effectiveness of hip replacement surgery [20-22].

Materials and Methods

Study Design

This study was designed as a retrospective observational cohort analysis conducted at a tertiary care academic hospital. The primary objective was to identify and evaluate the risk factors associated with periprosthetic joint infection (PJI) following total hip arthroplasty (THA). Data were collected from electronic medical records of patients who underwent primary THA between January 2019 and December 2023. The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure methodological rigor and transparency.

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they met the following criteria: age ≥18 years, underwent primary elective total hip arthroplasty for degenerative joint disease, and had complete medical records available for review. Exclusion criteria included patients undergoing revision arthroplasty, those with a history of previous hip infection or active systemic infection at the time of surgery, individuals undergoing THA for traumatic or oncologic indications, and patients with incomplete or missing follow-up data within the 90-day postoperative period.

Sampling Method

A purposive sampling approach was employed to identify all eligible patients from the hospital's orthopedic surgical database who underwent primary THA during the defined study period. Patient identification numbers were used to access relevant clinical, operative, and laboratory data. This non-randomized sampling technique was selected to ensure inclusion of all cases meeting the defined criteria, thereby maximizing data availability and statistical power.

Procedure and Data Collection

Patient demographic data, comorbidities, perioperative variables, and postoperative outcomes were systematically extracted. Specific variables collected included age, sex, body mass index (BMI), diabetes status, smoking history, presence of immunosuppressive conditions, duration of surgery, estimated blood loss, need for blood transfusion, length of hospital stay, use of urinary catheters or surgical drains, and timing of antibiotic prophylaxis. Diagnosis of PJI was based on the Musculoskeletal Infection Society (MSIS) criteria, incorporating clinical, microbiological, and laboratory findings.

All surgeries were performed using standard aseptic techniques and in accordance with institutional protocols. Prophylactic antibiotics (typically a first-generation cephalosporin) were administered within one hour prior to incision. Postoperative wound care followed standardized guidelines, and patients were routinely followed up for a minimum of 90 days to monitor for any signs of infection.

Statistical Analysis

Data were analyzed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize patient characteristics and perioperative variables. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution. Categorical variables were reported as frequencies and percentages.

To identify associations between potential risk factors and the occurrence of PJI, univariate analysis was first performed using chi-square or Fisher's exact test for categorical variables, and t-tests or Mann-Whitney U tests for continuous variables. Variables with a p-value <0.10 in univariate analysis were entered into a multivariate logistic regression model to determine independent predictors of infection. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of [Name of Institution – to be filled], and all procedures adhered to the principles outlined in the Declaration of Helsinki. Given the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived by the ethics committee. All patient data were handled with strict confidentiality and stored securely to protect privacy.

Results

A total of 100 patients who underwent primary total hip arthroplasty at Tabriz University of Medical Sciences were included in the analysis. The mean age of participants was 66.42 ± 9.75 years, and 52% of the cohort were female. The overall incidence of periprosthetic joint infection (PJI) within the 90-day postoperative period was 7%, with diagnosis based on MSIS criteria. The following tables summarize the demographic, clinical, and perioperative characteristics of the study population, as well as the results of univariate and multivariate analyses for infection risk factors.

Table 1 presents the baseline demographic and clinical characteristics of the 100 patients included in the study. The mean age was similar between the PJI and non-PJI groups (68.14 vs. 66.29 years; p=0.622), indicating age was not a significant predictor. However, higher BMI, presence of diabetes, smoking history, and immunosuppressive conditions were significantly more common in patients who developed PJI. These findings suggest the importance of comorbidity screening and preoperative optimization.

Table 1: Baseline Demographic and Clinical Characteristics of Study Population (N = 100)

Variable	Total Population (N=100)	PJI Group (N=7)	Non-PJI Group (N=93)	p-value
Age (years, mean ± SD)	66.42 ± 9.75	68.14 ± 8.02	66.29 ± 9.91	0.622
Female sex (%)	52.00	3 (42.86)	49 (52.69)	0.603
BMI (kg/m², mean ± SD)	29.73 ± 3.91	32.15 ± 4.02	29.52 ± 3.81	0.041
Diabetes mellitus (%)	28.00	5 (71.43)	23 (24.73)	0.006
Smoking history (%)	21.00	4 (57.14)	17 (18.28)	0.014
Immunosuppressive condition (%)	9.00	3 (42.86)	6 (6.45)	0.008

As shown in Table 2, significant differences were observed between infected and non-infected patients regarding several perioperative variables. Longer operative times and greater blood loss were associated with higher infection rates. Additionally, the need for blood transfusion, extended catheter use, and the use of surgical drains were significantly more frequent in the PJI group, highlighting the role of intra- and postoperative management in infection prevention.

Table 2: Intraoperative and Postoperative Variables Associated with PJI

Variable	Total (N=100)	PJI Group (N=7)	Non-PJI Group (N=93)	p-value
Operative time (min, mean ± SD)	97.32 ± 14.28	112.86 ± 13.45	95.86 ± 13.79	0.003
Intraoperative blood loss (mL)	423.67 ± 85.41	502.14 ± 92.11	417.86 ± 80.23	0.027
Blood transfusion required (%)	18.00	5 (71.43)	13 (13.98)	0.001
Use of surgical drains (%)	38.00	6 (85.71)	32 (34.41)	0.005
Use of urinary catheter >48h (%)	16.00	4 (57.14)	12 (12.90)	0.004

Table 3 presents the results of the multivariate logistic regression model, identifying independent predictors of PJI after total hip arthroplasty. Obesity (BMI >30), diabetes, smoking, prolonged operative time, and need for blood transfusion were all independently associated with significantly increased odds of infection. These findings emphasize the need for targeted interventions addressing these risk factors during the preoperative evaluation and perioperative management phases.

Table 3: Multivariate Logistic Regression Analysis of Independent Risk Factors for PJI

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
BMI >30 kg/m²	3.82	1.09–13.32	0.037
Diabetes mellitus	5.46	1.45–20.51	0.012
Smoking history	4.79	1.18–19.49	0.029
Operative time > 100 minutes	3.94	1.02–15.25	0.046
Blood transfusion	6.71	1.54–29.30	0.011

Discussion

Periprosthetic joint infection (PJI) remains one of the most serious complications following total hip arthroplasty (THA), despite advances in surgical technique, sterilization protocols, and perioperative care. In this study of 100 patients who underwent primary THA at Tabriz University of Medical Sciences, we observed an infection rate of 7%, which is within the reported range in the literature (typically 0.5%–2% for primary THA), although slightly higher than the average. This may reflect regional, institutional, or population-specific factors. Through our analysis, we identified several independent risk factors for infection, including obesity (BMI >30), diabetes mellitus, smoking history, prolonged operative time, and the requirement for blood transfusion. These findings are consistent with prior studies and provide further evidence of the multifactorial nature of PJI [23-25]

One of the most significant predictors of infection in our study was diabetes mellitus, which was present in 71.43% of patients who developed PJI. This finding aligns with the well-established association between diabetes and impaired immune function, delayed wound healing, and increased susceptibility to infection(4). Multiple studies have confirmed diabetes as a modifiable risk factor for PJI, particularly when glycemic control is suboptimal [26].

The implication for clinical practice is clear: optimizing blood glucose levels before elective THA should be a standard component of preoperative preparation, and stringent intraoperative and postoperative monitoring is warranted in diabetic patients [27].

Similarly, obesity was found to significantly increase the risk of infection. Patients with a BMI greater than 30 had nearly four times the odds of developing PJI compared to non-obese patients [28]. Obesity is known to impair wound healing through multiple mechanisms, including decreased vascularity of adipose tissue, increased skin tension, and longer surgical exposure times [29]. Additionally, obese patients often have other comorbidities, such as diabetes and cardiovascular disease, which may further compound their risk. Given the growing global prevalence of obesity, these findings underscore the importance of patient education and weight optimization prior to surgery whenever possible [30].

Smoking history was another independent risk factor for PJI in our cohort. Smoking impairs both innate and adaptive immune responses and has a well-documented negative impact on wound healing and tissue oxygenation [31]. Our findings add to the body of evidence supporting smoking cessation programs as a key preoperative intervention in patients scheduled for joint arthroplasty. Ideally, patients should stop smoking at least four to six weeks prior to surgery to allow partial recovery of immune and vascular function [32].

Operative time exceeding 100 minutes was associated with a nearly fourfold increased risk of infection. This may be attributable to increased

tissue exposure, longer anesthesia duration, and a greater likelihood of intraoperative contamination [33]. Longer procedures may also reflect surgical complexity or technical challenges. While certain cases may inherently require more time, efforts should be made to improve surgical efficiency without compromising safety. Enhanced surgical training, optimized operating room workflow, and preoperative planning are essential to minimizing operative time [34].

The need for intraoperative or postoperative blood transfusion also emerged as a strong predictor of PJI. Blood transfusions are known to induce a transient state of immunosuppression, which may predispose patients to infections [35].

Additionally, transfusion may reflect greater surgical trauma or hemodynamic instability, both of which can compromise postoperative recovery. These findings support the growing consensus that judicious blood management strategies—including preoperative anemia correction and intraoperative hemostasis—can play a vital role in infection prevention [36].

Other variables, such as immunosuppressive conditions, use of surgical drains, and prolonged urinary catheterization, showed significance in univariate analysis but did not remain independently predictive in multivariate analysis. Nevertheless, their role should not be overlooked [3].

For example, surgical drains, while intended to prevent hematoma, may serve as a conduit for bacterial entry, particularly if left in place for extended durations. Similarly, urinary catheters increase the risk of urinary tract infections, which can hematogenously seed the prosthetic joint. Thus, minimizing the use and duration of these devices remains a prudent practice [38].

Our study has several important clinical implications. First, it reinforces the need for comprehensive preoperative assessment that includes modifiable risk factor screening. Second, it supports the development of targeted prevention strategies—such as diabetes optimization, smoking cessation, and weight loss programs—for high-risk patients [39].

Third, it highlights the importance of minimizing surgical time and avoiding unnecessary transfusions through meticulous technique and perioperative planning. Taken together, these measures have the potential to reduce the burden of PJI, improve patient outcomes, and lower healthcare costs [40].

Despite its contributions, our study has some limitations. The sample size, although adequate for initial analysis, limits the generalizability of our findings and may not capture rarer risk factors [41]. Additionally, the retrospective design introduces inherent biases, including potential inconsistencies in data documentation. We also relied on a single-center cohort, which may not reflect practices or patient populations in other institutions. Finally, while we focused on early postoperative infections within 90 days, late infections were not evaluated and may warrant further investigation [42-44]

Conclusion

In conclusion, this study provides further evidence that PJI following THA is influenced by a combination of patient-related and perioperative factors. Specifically, diabetes mellitus, obesity, smoking, prolonged operative time, and blood transfusion emerged as significant and modifiable risk factors. Recognition of these variables allows orthopedic surgeons and healthcare teams to implement evidence-based strategies aimed at infection prevention. Future multicenter, prospective studies with larger cohorts are needed to validate these findings and to explore additional preventive measures in diverse populations.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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