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Risk Factors for Periprosthetic Joint Infection After Primary Total Hip Arthroplasty: A Single-Centre Cohort Study

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Article

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Abstract

Background

Periprosthetic joint infection (PJI) remains one of the most severe complications following total hip arthroplasty (THA), with significant clinical and economic impacts. Identification of patient-related risk factors is essential for improving prevention and management strategies.

Methods

This retrospective observational study with supplementary prospective follow-up included 130 patients who underwent primary THA between January 2022 and December 2023. Demographic and clinical data, including age, sex, and ASA score, were collected from institutional records. Infection-related outcomes were assessed during follow-up. Statistical analysis included univariate comparisons and calculation of odds ratios (ORs) with 95% confidence intervals (CIs).

Results

The overall incidence of PJI was 4.6% (6/130). Patients who developed infection were significantly older than those without infection (86.67 ± 5.75 vs.. 77.93 ± 10.14 years; $p = 0.011$). Male sex was associated with a significantly higher risk of PJI (11.1% vs.. 2.1%; OR 5.75; 95% CI 1.00–32.90; $p = 0.049$). All infections occurred in patients with ASA score ≥ III, showing a strong association with infection risk (OR 117.0; 95% CI 5.89–2323.05; $p < 0.001$).

Conclusions

Advanced age, male sex, and higher ASA score were associated with an increased risk of PJI following primary THA. These findings highlight the importance of patient-related risk stratification and support the implementation of targeted perioperative strategies to reduce infection risk.

Introduction

Periprosthetic joint infection (PJI) following total hip arthroplasty (THA) is one of the most severe complications in contemporary orthopaedic surgery, with substantial implications for patient morbidity, mortality, functional outcomes, and healthcare costs [1–3]. Despite continuous advancements in surgical techniques, implant technology, and perioperative management, PJI has not been eliminated and remains one of the leading causes of revision arthroplasty worldwide [2, 4]. The pathogenesis of PJI is multifactorial and involves a complex interplay between patient-related and procedure-related factors, including host immune status, comorbidities, and intraoperative bacterial contamination [4, 5]. In recent years, increasing evidence from large cohort studies and meta-analyses has highlighted the significant

role of demographic and clinical variables in determining infection risk. In particular, male sex and systemic disease burden have been consistently identified as independent risk factors for PJI following primary arthroplasty [5–7].

From a pathophysiological perspective, periprosthetic infections may arise from intraoperative contamination, contiguous spread from adjacent tissues, or hematogenous dissemination from distant infectious foci. Gram-positive organisms, especially *Staphylococcus* species, are the most frequently isolated pathogens [8]. Clinically, PJI may present with a wide spectrum of manifestations ranging from acute systemic infection to more indolent symptoms, such as persistent joint pain, stiffness, and impaired function. Thus, accurate diagnosis requires a comprehensive and multidisciplinary approach that integrates clinical evaluation, laboratory biomarkers, microbiological cultures, and imaging findings. Internationally recognized diagnostic criteria, such as those proposed by Parvizi and colleagues and supported by international guidelines, have further standardized the definition of PJI in both clinical and research settings [9, 10].

Given the increasing incidence and clinical burden of PJI, considerable attention has been directed toward the identification of reliable risk stratification tools. The American Society of Anaesthesiologists (ASA) score has emerged as a widely used surrogate marker of overall patient frailty and systemic disease burden, and several studies have demonstrated its predictive value for postoperative complications, including infection [11, 12]. However, despite the growing body of literature, the relative contribution and interaction of demographic and clinical variables in specific patient populations have not been completely defined. Therefore, the aim of this study was to evaluate the incidence of PJI and to identify associated demographic and clinical risk factors in a cohort of patients undergoing primary total hip arthroplasty at a single tertiary referral centre. By improving risk stratification, the goal of this study is to support the development of targeted preventive strategies and optimized perioperative management protocols.

Materials and methods

Study design and ethical approval

This study was designed as a retrospective observational cohort study with supplementary prospective follow-up. It was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (24/2026/PAR). Informed consent was obtained from all patients involved in the follow-up data collection.

Patient selection

A total of 130 patients who underwent primary total hip arthroplasty between January 2022 and December 2023 were included. Patients were identified through institutional electronic medical records. The inclusion criteria were: (1) primary total hip arthroplasty; (2) minimum follow-up of 12 months; and

(3) perioperative antibiotic prophylaxis (2 g of cefazolin or 600 mg clindamycin in case of allergy) administered 30 minutes before surgery. The exclusion criteria included: (1) revision total hip arthroplasty; (2) hemiarthroplasty; and (3) fracture-related surgery.

Data collection

Baseline demographic and clinical data, including age, sex, and ASA score, were retrospectively collected from institutional electronic medical records. Additional information was retrieved using Carestream software when necessary. Follow-up data were collected prospectively using a structured questionnaire administered to patients.

Follow-up, outcome assessment, and definition of periprosthetic joint infection

Patients were evaluated during hospitalization and at 1, 3, 6, and 12 months after surgery. A standardized questionnaire was used to assess postoperative complications and infection-related symptoms, including fever, antibiotic use, wound abnormalities (swelling, redness, or discharge), limb pain, joint stiffness, and altered inflammatory markers (ESR and CRP). Periprosthetic joint infection was diagnosed based on clinical findings, laboratory parameters (including ESR and CRP), and microbiological confirmation, according to internationally accepted diagnostic criteria.

Statistical analysis

Continuous variables were expressed as the mean ± standard deviation (SD), while categorical variables were reported as absolute numbers and percentages. Comparisons between groups (PJI vs. non-PJI) were performed using Student's *t*-test for continuous variables after verifying an approximate normal distribution. Categorical variables were analysed using the chi-squared test, and when expected cell counts were less than 5, Fisher's exact test was applied.

The strength of association between potential risk factors and PJI was assessed using odds ratios (ORs) with corresponding 95% confidence intervals (CIs). Given the limited number of infection events, only univariate analysis was performed, and no multivariate regression models were applied to avoid model overfitting in accordance with standard statistical recommendations. A two-sided p-value < 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Results

Patient characteristics

Baseline demographic and clinical characteristics are reported in Table 1. A total of 130 patients undergoing primary total hip arthroplasty were included, and their mean age was 78.3 ± 10.1 years. The study population was predominantly female (72.3%), with males accounting for 27.7%. PJI occurred in 6 patients, corresponding to an overall incidence of 4.6%.

Table 1
Baseline characteristics of the study population

Variable	Total (*n* = 130)	PJI (*n* = 6)	No PJI (*n* = 124)	*p*-value
Age, years (mean ± SD)	78.3 ± 10.1	86.67 ± 5.75	77.93 ± 10.14	0.011
Male sex, n (%)	36 (27.7)	4 (66.7)	32 (25.8)	0.029
Female sex, n (%)	94 (72.3)	2 (33.3)	92 (74.2)	—
ASA I–II, n (%)	58 (82.9*)	0 (0)	58 (100)	< 0.001
ASA III–IV, n (%)	12 (17.1*)	6 (100)	6 (0)	—

*ASA score available in 70 patients.

Caption

Baseline demographic and clinical characteristics of patients undergoing primary total hip arthroplasty, stratified according to the occurrence of periprosthetic joint infection (PJI).

Footnote

Continuous variables were compared using Student's *t*-test; categorical variables using chi-squared or Fisher's exact test where appropriate.

Patients who developed PJI were significantly older than those who did not (86.67 ± 5.75 vs 77.93 ± 10.14 years; $p = 0.011$) (Table 1). The mean difference in age between groups was 8.74 years. Sex-based analysis showed a higher infection rate among male patients. Specifically, PJI occurred in 4 out of 36 males (11.1%) compared to 2 out of 94 females (2.1%) (Table 1). This difference was statistically significant ($p = 0.029$). Univariate analysis (Table 2) confirmed that male sex was associated with an increased likelihood of infection (OR 5.75; 95% CI 1.00–32.90; $p = 0.049$).

Table 2
Univariate analysis of risk factors for periprosthetic joint infection

Variable	OR	95% CI	*p*-value
Age (continuous)	—	—	0.011
Male sex (vs. female)	5.75	1.00–32.90	0.049*
ASA III–IV (vs. I–II)	117.0†	5.89–2323.05	< 0.001*
*Fisher's exact test			

†Estimated using Haldane–Anscombe correction due to zero events in ASA I–II group

Caption

Univariate analysis of demographic and clinical variables associated with periprosthetic joint infection.

Footnote

Odds ratios (OR) with 95% confidence intervals (CI) were calculated where applicable. Age was analysed as a continuous variable using Student's t-test. Fisher's exact test was applied when expected cell counts were < 5.

ASA score

The ASA score was available for 70 patients (Table 1). No infections were observed among patients with ASA I–II, whereas all infections occurred in patients with ASA III–IV. In detail, infections occurred in 4 patients with ASA III and 2 patients with ASA IV. The association between ASA score and infection was highly significant ($p < 0.001$). Univariate analysis (Table 2) showed that patients with ASA III–IV had a markedly increased risk of infection compared to those with ASA I–II (OR 117.0; 95% CI 5.89–2323.05). However, the wide CIs reflect the limited precision of the estimate due to the small number of events.

Discussion

Main findings

In this study, we evaluated the incidence and risk factors associated with PJI following primary total hip arthroplasty. The overall infection rate was 4.6%, and advanced age, male sex, and higher ASA score were significantly associated with infection. These findings confirm previously reported associations and provide quantitative evidence of their relevance in a real-world clinical setting [5–7, 13].

Incidence of PJI

The observed incidence of 4.6% is higher than the rate of 1–2% typically reported in large registry-based and population studies [2, 4, 14]. Large registry-based studies have reported infection rates below 2% following primary total hip arthroplasty, while long-term registry data have shown an increasing trend in revision due to infection over time [4, 14]. However, recent evidence suggests that PJI incidence may be underestimated in large datasets due to variability in diagnostic criteria and reporting methods [2]. Therefore, the higher incidence observed in our study may reflect a population with greater comorbidity burden or more accurate detection.

Age

Our results showed that patients with PJI were significantly older, with a mean difference of approximately 9 years. This finding is consistent with meta-analyses identifying advanced age as a risk factor for infection [5, 13], although these studies also highlight the role of comorbidities as key confounders. Nevertheless, large cohort studies suggest that age is often not an independent predictor once comorbidities are considered and acts instead as a surrogate marker of frailty [6, 7]. Our findings support this interpretation.

Sex differences

Male sex was associated with an approximately sixfold increased risk of infection in our cohort. In contrast, meta-analyses report smaller effect sizes, with ORs typically ranging between 1.3 and 1.5 [5, 6, 13]. The higher OR in our study is likely due to the limited sample size and the small number of events. This is also reflected by the wide confidence intervals, indicating limited precision of the estimate.

ASA score

The strongest association observed in our study was between higher ASA scores and infection, with all cases occurring in patients with ASA III–IV. This is consistent with studies demonstrating that ASA classification is a reliable predictor of postoperative complications [11] and has been associated with increased risk of PJI [12, 15]. Our results highlight the clinical relevance of the ASA score as a simple and effective tool for risk stratification. However, the wide CIs observed for this variable reflect the limited precision of the estimate due to the small number of events.

Comorbidities and clinical implications

Extensive literature has demonstrated that comorbidities such as obesity, diabetes, and metabolic disorders significantly increase the risk of PJI [12, 15–19]. For example, Bozic et al. identified multiple patient-related factors contributing to infection risk [19], while recent studies have shown that severe obesity can increase the risk of PJI by up to ninefold [18]. These findings reinforce the concept that PJI is a multifactorial condition influenced by the interaction of multiple risk factors. The identification of a high-risk profile characterized by advanced age, male sex, and elevated ASA score has important implications for clinical practice. Targeted strategies, including optimization of comorbidities, improved perioperative management, and closer follow-up, may help to reduce infection rates [10, 20].

Strengths and limitations

This study has several limitations, including the small number of infection events, the retrospective design, and the absence of multivariate analysis. These factors limit the ability to draw causal conclusions and may have influenced the estimated effect sizes. Despite these limitations, our findings are consistent with high-level evidence from meta-analyses and large cohort studies, which support their external validity [5, 13].

Conclusions

In this study, advanced age, male sex, and higher ASA score were significantly associated with an increased risk of PJI following primary total hip arthroplasty. Although these factors are well established in the literature, our findings confirm their combined impact in a real-world clinical setting and highlight the importance of patient-related characteristics in the development of infection. The identification of a high-risk profile may support improved preoperative risk stratification and guide targeted perioperative optimization strategies aimed at reducing the incidence of PJI. Further studies with larger cohorts are needed to better define independent predictors and to validate risk stratification models in this patient population.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee (Comitato Etico Locale Catania 1) of Azienda Ospedaliero-Universitaria Policlinico "G. Rodolico-San Marco", Catania, Italy (Approval No. 24/2026/PAR). Written informed consent was obtained from all participants prior to their inclusion in the follow-up data collection.

Consent for publication

Not applicable. The manuscript does not contain any individual person’s data, images, or identifying clinical information.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

All authors contributed to the study conception and design. Data collection, and analysis were performed by the authors. All authors contributed to manuscript drafting and revision, and all authors read and approved the final manuscript.

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Not applicable.

Data Availability

The data analyzed during this study were obtained from medical records. Due to patient confidentiality and institutional privacy regulations, the datasets are not publicly available but are available from the corresponding author on reasonable request, subject to approval by the relevant ethics committee and institution.

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