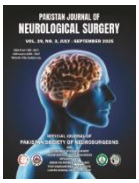

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Original Research

Risk Factors for Postoperative Spinal Infections Following Instrumented Spine Surgery: A Case-Control Study of 500 Cases

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ABSTRACT

Objective: Postoperative spinal infections are a significant complication of instrumented spine surgery, contributing to increased morbidity and healthcare costs. This case-control study aimed to identify the risk factors associated with postoperative infections in patients undergoing instrumented spine surgery.

Materials and Methods: We carried out a retrospective case-control study involving 500 patients who underwent instrumented spine surgery at Lady Reading Hospital, Peshawar, between January 2019 and December 2023. Among them, 50 patients (10%) developed postoperative infections and were categorized as the case group, while the remaining 450 patients without infections formed the control group. Data were collected on sociodemographic characteristics, comorbidities, surgical factors, and postoperative care. To identify independent predictors of disease, we applied multivariate logistic regression analysis. A p-value of less than 0.05 was considered statistically significant.

Results: Diabetes mellitus (OR 3.5, p = 0.01), prolonged surgical time (>3 hours) (OR 3.1, p = 0.02), obesity (OR 2.9, p = 0.03), and insufficient antibiotic prophylaxis (OR 2.6, p = 0.04) were significantly associated with postoperative infections. Extended hospital stay was recorded in patients having post-operative infection or multiple readmissions, and reoperation was high.

Conclusion: Factors like diabetes mellitus, extended duration of surgery, obesity, and Failure to appropriately use prophylactic antibiotics may contribute to an elevated risk of infections following surgery. Recognizing these risk factors early and modifying them can reduce the burden of postoperative infection.

Keywords: Postoperative Infections; Instrumented Spine Surgery; Risk Factors; Diabetes Mellitus; Obesity; Prophylactic Antibiotics; Prolonged Surgery; Surgical Site Infections (SSI).

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INTRODUCTION

Postoperative infection is a serious complication associated with spinal surgery, with its incidence rising due to the increasing complexity of procedures and the diverse patient populations involved. Spinal fusion surgery and stabilization are commonly performed to treat a range of conditions, including traumatic injuries, degenerative disorders, and congenital or structural abnormalities of the spine.[1]

These procedures are crucial for improving patient outcomes. Still, they also carry a risk of postoperative infections, which can lead to serious consequences, including extended hospital stays, the need for reoperations, long-term complications, and increased healthcare costs.[2,3] Given the associated rise in patient morbidity and the burden on healthcare systems. Preventing and effectively managing postoperative infections remains a critical priority.

Post-operative spinal infections are linked to various causes, including underlying health conditions, the duration of the surgery, and the standard of perioperative care provided. Diabetes, obesity, and prolonged surgical times are potential contributors to an increased risk of infection; these associations require further investigation, particularly in healthcare settings beyond high-income countries. Administering antibiotics during the perioperative period is a standard preventive measure, but practices vary widely. There is still no clear consensus among medical professionals regarding the optimal type or timing of antibiotic use before surgery.[3]

Metallic implants used in spinal surgeries may raise the risk of biofilm development and bacterial proliferation on their surfaces. As a result, these biofilms can hinder treatment and extend recovery time, rendering infections harder to control and treat.[5] While commonly examined risk factors like obesity, diabetes, and lengthy surgeries are often acknowledged, additional elements such as nutritional status,[6] preoperative fitness, and smoking,[7,8] may also play vital roles but are less explored. In healthcare systems with limited resources, the combined effects of these variables are not entirely understood and require closer examination.

The complexity and variability in postoperative care, including infection control practices, surgical site care, and hospital environment, may increase the risk of infection in ways that have not been fully quantified. In low-resource areas such as Pakistan, these potential risk factors, while recognized in some studies, are not universally considered, and their relative impact on determining postoperative infections in spine surgeries remains unclear. Understanding how these factors interact and influence postoperative outcomes is critical for developing effective preventive strategies.

This study aimed to explore these potential risk factors, spanning both patient-related and procedural aspects, within the context of a tertiary care hospital in Pakistan. By evaluating a range of factors, including comorbidities, duration of surgery, perioperative care, and hospital practices, this study aims to determine whether the commonly suggested risk factors apply to this population or if other, less well-identified influences on postoperative infections will emerge. This study aimed to offer new insights that can help enhance strategies for infection prevention and improve the outcomes of instrumented spine surgery.

MATERIALS AND METHODS

Study Design and Settings

This case-control study, conducted retrospectively, included 500 patients who underwent instrumented spine surgery at the Neurosurgery Department of Lady Reading Hospital in Peshawar. This study was conducted from January 2019 to December 2023, following approval from the hospital's Institutional Review

Board (Ref No: 65/LRH/MTI). The requirement for individual patient consent was waived due to the retrospective nature of the study and the use of anonymized data.

Study Population

A total of 500 patients were included. Among the study population, 50 patients who developed postoperative spinal infections were categorized as the case group, while the remaining 450 patients without infections served as the control group. All participants were aged eighteen years or above and had complete medical records. Patients with incomplete records or a prior history of spinal infections were excluded from the study.

Data Acquisition

Data were collected on patient demographics, preoperative comorbidities (e.g., diabetes, hypertension, obesity), surgical data (e.g., operative time/duration, blood loss, level of instrumentation), and postoperative management (e.g., administration of prophylactic antibiotics, duration of hospital stay).

Statistical Analysis

SPSS version 26 was used to perform statistical analysis, including multivariate logistic regression to evaluate key variables and identify independent risk factors for postoperative infection, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Demographics and Clinical Characteristics

The patients' average age was 56.4 ± 10.5 years, with a predominance of males (60% male, 40% female). The infection rate was 10%, with 50 patients developing postoperative infection. Diabetes mellitus was present in 28% of cases, whereas only 12% of controls had diabetes (p = 0.01). The mean BMI of the infection group was 30.9 ± 4.3 kg/m^2, compared with 27.2 ± 3.8 kg/m^2 in the control group (p = 0.03).

Table 1: *Baseline Demographic and Clinical Profile of Participants.*

Variable	Cases (n=50)	Controls (n=450)	p-value
Age (mean ± SD)	56.4 ± 10.5	54.2 ± 9.7	0.08
Male (%)	60% (30)	55% (248)	0.45
Diabetes Mellitus	28% (14)	12% (54)	0.01
BMI (kg/m^2)	30.9 ± 4.3	27.2 ± 3.8	0.03
Hypertension (%)	24% (12)	18% (81)	0.3

Diabetes mellitus and BMI were significantly higher in the infection group than in the control group, with p-values of 0.01 and 0.03, respectively. Hypertension had a statistically insignificant p-value of 0.30.

Risk Factors for Postoperative Infections

The analysis revealed significant associations between prolonged operative time (> 3 hours) and infection rates, with 58% of cases having extended surgery times compared to 23% of controls (p = 0.02). Inadequate prophylactic antibiotic use was also a significant risk factor, with only 45% of infected patients receiving appropriate antibiotics

Table 2: *Intraoperative and Postoperative Risk Factors.*

Variable	Cases (n=50)	Controls (n=450)	OR	p-value
Operative Time >3 hours	58% (29)	23% (104)	3.1	0.02
Intraoperative Blood Loss >500ml	40% (20)	18% (81)	2.6	0.04
Prophylactic Antibiotics Given	45% (22)	85% (383)	0.5	0.03
Reoperation Rate	12% (6)	3% (13)	4	0.01

compared to 85% of the controls (p = 0.03). Prolonged operative time, intraoperative blood loss, and inadequate prophylactic antibiotics were significantly associated with higher infection rates (p = 0.02, 0.04, and 0.03, respectively).

Lumbar and thoracic fusion showed significantly higher infection rates than controls, with p-values of 0.04 and 0.03, respectively.

Table 3: *Infection Rates Based on Surgical Procedure*

Procedure	Cases (n=50)	Controls (n=450)	p-value
Lumbar Fusion	60% (30)	50% (225)	0.04
Cervical Fusion	20% (10)	25% (112)	0.08
Thoracic Fusion	10% (5)	5% (22)	0.03
Combined Fusions	10% (5)	20% (91)	0.03

DISCUSSION

Our study identified several independent risk factors associated with postoperative infections following instrumented spinal surgery. These include extended operative duration, obesity, diabetes mellitus, and insufficient use of prophylactic antibiotics. These results align with findings from earlier research that emphasize the importance of addressing modifiable risk factors to reduce infection rates.[1,9,10]

Diabetes mellitus was present in 28% of patients who developed postoperative infections, demonstrating a strong correlation with increased infection risk. The susceptibility of individuals with poorly controlled diabetes undergoing spinal procedures is well recognized. A meta-analysis by Fei et al,[1] found a significant association between diabetes and postoperative infection, reporting a risk ratio of 2.22 (95% CI: 1.38–3.60; p = 0.001). Similarly, Koutsoumbelis et al, and Olsen et al,[4] found diabetes to be an independent predictor of surgical site infection, with Olsen reporting an odds ratio of 3.5 (95% CI: 1.2–10.0). These findings are in line with our results and reinforce the importance of preoperative optimization of glycemic control.

Obesity also emerged as a notable contributor to infection. In our cohort, 50% of patients with infections had a BMI over 30 kg/m^2, compared to only 20% in the control group. Excess body fat can compromise wound healing, raise the likelihood of contamination, and make maintaining a sterile operative field more difficult. Abdullah et al,[11] reported that for every 5-unit rise in BMI, the risk of spinal surgical site infection increased by 21%, even after adjusting for comorbidities (adjusted OR: 1.21; 95% CI: 1.13–1.29; p < 0.0001). Jackson et al,[12] similarly noted a greater frequency of infections and poorer functional outcomes in obese patients undergoing spinal surgery.

Prolonged operative time was another significant factor. Among the infected group, 58% underwent procedures exceeding three hours, whereas only 23% of the control group had similarly long surgeries. This trend mirrors findings from Peng et al,[13] and Kadi et al,[14] who reported higher infection rates with extended surgical durations. Longer procedures likely increase exposure of tissues to environmental contaminants and contribute to tissue ischemia and immune suppression. Our results suggest that minimizing operative time, when possible, may help reduce postoperative infection risks.

Antibiotic prophylaxis also had a marked impact. Only 45% of patients who developed surgical site infections had received preoperative antibiotics, compared to 85% in the control group. This supports the findings of Kanayama et al,[15] who demonstrated that a single perioperative antibiotic dose effectively reduced infection risk in spine surgery. While many international guidelines promote standardized antibiotic use, our setting highlighted a critical gap—some patients received no antibiotics at all—emphasizing the urgent need for improved adherence to even basic prophylactic protocols in resource-limited environments.

Postoperative infections were also associated with significantly longer hospital stays and higher

reoperation rates. Patients with infections stayed an average of 14.2 days, while controls stayed 6.8 days. The reoperation rate was 12% in the infected group, compared to just 3% in controls. Illyas et al,[16] reported similar findings, noting that surgical site infections significantly increased the likelihood of both reoperation (OR 25.06, 95% CI: 13.54–46.51) and hospital readmission (OR 14.09, 95% CI: 7.86–25.18). Zuo et al,[17] further highlighted the financial burden associated with such infections, demonstrating that they lead to increased hospital costs and economic strain on patients.

LIMITATIONS

This study has several limitations. It was a retrospective analysis conducted at a single tertiary care center, which may limit the generalizability of the findings to other settings. Additionally, retrospective data collection prevented us from accounting for some potentially influential variables, such as nutritional status, smoking history, and other lifestyle factors. Despite these constraints, the study provides important insights into the risk factors contributing to postoperative infections in spinal surgery and underscores the need for prospective, multicenter research using standardized protocols to validate and build upon these findings.

CONCLUSION

Postoperative spinal infections are often linked to risk factors such as diabetes, obesity, and long duration of surgery. Our study also found a positive correlation between these risk factors. Assess these risk factors preoperatively in patients, and timely addressing these can help reduce the burden of postoperative infection in spinal instrumented surgery.

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Additional Information

Disclosures: The Authors report no conflict of interest.

Ethical Review Board Approval: Approval was taken from the IRB committee of Lady Reading Hospital, Peshawar. (Ref No: 65/LRH/MTI).

Human Subjects: The requirement for individual patient consent was waived due to the retrospective nature of the study and the use of anonymized data.

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Financial Relationships: All authors have declared that they have no financial relationships at present or within the The previous three years with any organizations that might have an interest in the submitted work.

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Muhammad Nawaz Khan	Study design and methodology and Literature review.
2.	Muhammad Sohaib Khan	Paper writing, Editing and quality insurer.
3.	Adnan Khan	Analysis of data and interpretation of results.
4.	Ijaz Ul Haque	Data collection and calculations.
5.	Syed Shayan Shah	Data Collection and referencing.