



## Incidence and Risk Factors of Surgical Site Infection Following Orthopedic Implant Surgeries in a tertiary Healthcare setting at Lahore

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### ABSTRACT

**Background:** Surgical site infections (SSIs) are a leading cause of postoperative morbidity following orthopedic implant surgeries, resulting in delayed recovery and high healthcare costs. The aim of this study was to establish the incidence and the risk factors of SSIs after orthopedic implant surgery.

**Methods:** This descriptive cross-sectional study (April 2024 to July) enrolled 180 patients aged 18 years and above who were undergoing orthopedic implant surgeries. A structured proforma was used to collect data on demographic, clinical and perioperative variables. According to the Centers for Disease Control and Prevention (CDC) guidelines, SSIs were detected. The SPSS version 26.0 was used to perform the statistical analysis using the chi-square and t-tests to make the univariate comparisons and multivariate logistic regression to identify the

independent predictors of SSI. A p-value of <0.05 was considered statistically significant.

**Results:** The total incidence of SSIs was 11.7%(n=21). SSIs were significantly related to diabetes mellitus (p = 0.01), smoking (p = 0.03), and prolonged surgical duration (>2 hour, p = 0.02), as well as antibiotic prophylaxis (p = 0.001) deficit. These were affirmed as independent predictors using multivariate analysis: diabetes (Adjusted Odds Ratio (AOR) = 2.84), smoking (AOR = 2.19), duration more than 2 hours (AOR = 2.61), and no antibiotic prophylaxis (AOR = 4.73).

**Conclusion:** The incidence of SSI was considerably high in orthopedic implant surgeries. The risk of infection can be reduced significantly by optimizing the use of perioperative antibiotics, controlling diabetes, reducing the length of operation, and deterring smoking

**Keywords:** Surgical Wound Infection, Orthopedic Procedures, Implants, Risk Factors, Antibiotic Prophylaxis, Postoperative Complications.

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## INTRODUCTION

Surgical site infections (SSIs) are among the most widespread and expensive complications of surgical procedures across the world <sup>1</sup>. They are a major cause of postoperative morbidity, and lead to prolonged hospitalization, slow healing of the wound and in worst cases, loss of implants or even death <sup>2</sup>. Orthopedic implant surgeries are one of the most susceptible surgeries to infections because foreign particles are introduced that serves as surfaces for bacterial adherence and form biofilms <sup>3</sup>. Despite the continuing improvement of sterilization methods, antimicrobial prophylaxis, and perioperative infection control practices, SSIs still remain a significant clinical and economic burden to patients and healthcare systems <sup>4</sup>.

The prevalence of SSI following orthopedic surgery varies worldwide between 1% and 10%, based on the type of surgery, patient demographics, and institutional infection management <sup>5</sup>. The SSI pathogenesis is complex because it includes a mixture of patient, procedural, and environmental factors <sup>6</sup>. The host related factors are closely related to the increased risk of postoperative infection which includes; diabetes mellitus, obesity, smoking, malnutrition and immune suppression <sup>7</sup>. Moreover, the duration of surgery, the overabundance of tissue trauma, improper handling of implants and contamination during wound closure play a major role in enhancing susceptibility <sup>8</sup>. Orthopedic implants offer another complication since biofilm-forming microorganisms, especially *Staphylococcus aureus* and *Staphylococcus epidermidis*, can colonize on the implant surface and effectively avoid host immune response resulting in persistent and hard-to-clear infection <sup>9</sup>. Nevertheless, the incidence and pattern of risk factors may be different in various surgical settings and populations <sup>10</sup>. Such determinants need to be identified within local settings in order to empower the prevention of infections.

The purpose of the present study was to identify the incidence of the surgical site infections in patients undergoing orthopedic implant surgeries and to assess patient-related, surgical, and implant-related risk factors that lead to the occurrence of the infection.

## METHODS

This descriptive cross-sectional study (April 2024 to July) enrolled 180 patients aged 18 years and above who were undergoing orthopedic implant surgeries (Ref: 2256/AST/2024) from departments of surgery, ASMC Lahore and AIMH Gujranwala followed by an informed consent.

There were 180 patients who received orthopedic implant procedures within the study period. The OpenEpi sample size calculator was used to calculate the sample size, with an expected SSI

prevalence of 12, 95% confidence level, and 5% margin of error<sup>11</sup>, which yielded a minimum required sample of 163 patients. In order to improve reliability, 180 cases were enlisted. A non-probability consecutive sampling was used. Patients aged 18 years and above undergoing elective or emergency orthopedic implant surgery (lower-limb and upper-limb operations), were all included. Patients with preoperative infections in the surgical site that received long-term antibiotics prior to surgery, lack of full operative records or lost postoperative follow-up within 30 days were excluded.

A structured performa with demographic, comorbidity (e.g., diabetes, smoking, obesity), type and duration of surgery, implant material, antibiotic prophylaxis, and postoperative wound care was used to collect data. Institutional protocol was used to administer antibiotic prophylaxis. Prophylaxis effectiveness was evaluated based on antibiotic type, time of administration (before 60 minutes of incision) and duration. The most frequently used prophylactic agent was Cefazolin; whereas in some cases clindamycin was also used in individuals with  $\beta$ -lactam allergy. The cases when no prophylaxis has been given or when the timing and selection of antibiotic have been improper were classified as poor prophylaxis. Operation time was documented as time taken between incision and stitching and was divided into >2 hours and <2 hours.

Wound evaluation was conducted on the 3rd, 7th and 30th day post-operative. The SSI diagnosis was based on CDC criteria that characterizes SSI as a superficial incisional, deep incisional, or organ infection. The standard cultures were used to conduct microbiological analysis on infected wounds, where necessary.

The SPSS version 26.0 (IBM Corp., Armonk, NY) was used to analyze data. All variables were calculated using descriptive statistics. Univariate analysis was done using chi-square and independent t-tests. Those variables whose p value is less than 0.10 were included in a multivariate logistic regression equation to determine independent predictors of SSI. A p-value of less than 0.05 was considered statistically significant

## RESULTS

**Table 1: Baseline Demographic and Clinical Characteristics of Participants (n = 180)**

Variable	Non-SSI (n = 159)	SSI (n = 21)	p-value
Age (years)	44.2 ± 13.1	46.8 ± 13.8	0.28
Gender			

Male	98 (61.6%)	14 (66.7%)	0.65
Female	61 (38.4%)	7 (33.3%)	
<b>BMI (kg/m<sup>2</sup>)</b>	26.5 ± 3.8	27.4 ± 4.1	0.12
<b>Diabetes Mellitus</b>	37 (23.3%)	11 (52.4%)	0.01*
<b>Smoking History</b>	31 (19.5%)	10 (47.6%)	0.03*

SSI: Surgical Site Infection, SD: Standard Deviation, t: student's t-test,  $\chi^2$  = Chi-square statistic;  $p < 0.05$  considered significant, *df*: degree of freedom.

This study includes 180 patients who undergo orthopedic implant surgery. Participants ranged in age from 18 to 72 years old, with a mean age of  $44.6 \pm 13.2$  years. Of these, 68 (37.8%) were female and 112 (62.2%) were male. Of the patients, 65 (36.1%) had upper-limb implant surgery while the majority 115 (63.9%) had lower-limb implant surgery. The total incidence of surgical site infection (SSI) according to CDC diagnostic criteria was 11.7% ( $n = 21$ ). The baseline clinical and demographic features of the research population are presented in **Table 1**.

**Table 2: Surgical and Perioperative Factors Related to SSI Incidence**

Variable	Non-SSI (n = 159)	SSI (n = 21)	p-value
Duration of Surgery > 2 hours	46 (28.9%)	12 (57.1%)	<b>0.02*</b>
Emergency Surgery	38 (23.9%)	8 (38.1%)	0.16
Preoperative Antibiotic Prophylaxis	152 (95.6%)	15 (71.4%)	<b>0.001*</b>
Implant Type			
Steel	92 (57.9%)	12 (57.1%)	0.93
Titanium	67 (42.1%)	9 (42.9%)	
Type of limb surgery			
Upper limb	58 (36.5%)	7 (33.3%)	0.76

Lower limb	101 (63.5%)	14 (66.7%)	
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SSI = Surgical Site Infection;  $p < 0.05$  indicates statistical significance,

BMI, age, and gender were not statistically significant predictors of SSI occurrence, although diabetes and smoking status were significant with  $p$ -value =0.01 and  $p$ -value=0.03, respectively.

Perioperative and surgical variables are categorized by SSI status in **Table 2**.

**Table 3: Multivariate Logistic Regression of Independent Risk Factors for SSI**

Risk Factor	Adjusted OR	95% CI	p-value
Diabetes Mellitus	2.84	1.21–6.62	<b>0.01*</b>
Smoking	2.19	1.07–4.91	<b>0.03*</b>
Duration > 2 hours	2.61	1.18–5.74	<b>0.02*</b>
No Antibiotic Prophylaxis	4.73	1.68–10.92	<b>0.001*</b>

OR = Odds Ratio; CI = Confidence Interval;  $p < 0.05$  statistically significant.

Lack of proper antibiotic prophylaxis and extended surgical length were strongly linked to the development of SSI ( $p=0.001$ ,  $p=0.02$ , respectively). There was no discernible correlation among limb type, implant type and the requirement for emergency surgery. Multivariate logistic regression's adjusted interactions are shown in **Table 3**. After controlling for confounding variables, diabetes mellitus, smoking, longer surgery times, and non-prophylactic use of antibiotics were still statistically significant.

## DISCUSSION

The current research examined the incidence and predisposing factors of surgical site infection (SSI) among orthopedic implant surgeries. The significant independent predictors of SSI identified were diabetes mellitus, smoking, prolong operating time (>2 hours), and lack of preoperative antibiotic prophylaxis. The other factors like age, gender, type of implant material and emergency

status did not correlate significantly. These results underline the multifactorial quality of SSIs and the importance of the practice of strict infections control in orthopedic surgery.

The identified SSI rate of 11.7% is consistent with previously reported rates of 10–15% following orthopedic implant procedures<sup>12</sup>. Notably, the rate is similar to the reported rates (ranging between 9% and 18%) of SSI in South Asia and other neighbouring low- to middle-income nations, following orthopedic procedures<sup>13</sup>. Previous research has demonstrated that there is a higher probability of infection due to longer period of operation especially after two hours<sup>14</sup>. The increased microbial contamination and tissue devitalization can also occur due to the longer exposure time used in the surgery. This observation also coincides with previous a study that underlines the need to explain the efficiency of the surgery, as well as reduce the risk of infection<sup>15</sup>. Taken together, these studies confirm that one of the most predictable modifiable risk factors of the SSI is the extended time of operations.

The current investigation identified diabetes mellitus and smoking as significant predictors of SSI development. Diabetes predisposes infection in various ways that impede wound healing because of impaired neutrophil functioning, decreased neutrophil chemotaxis, dysfunction of microvascular cells, and delayed collagen production.<sup>16</sup> On the same note, smoking has been demonstrated to impede tissue perfusion and oxygenation, which slows wound repair and enhances the colonization by bacteria<sup>17,18</sup>. Research has also indicated that patients with diabetes who undergo orthopedic implant are almost three times at risk of infection than patients without diabetes<sup>19</sup>. The relatively similarity of these results with previous literature supports the significance of preoperative optimization of metabolic control and smoking cessation to reduce the risk of SSI.

Antibiotic prophylaxis showed a protective effect against SSI and there was significantly higher rate of infections in patients who were not given preoperative antibiotics. The given finding confirms the current clinical guidelines, suggesting the use of prophylactic antibiotics within one hour before incision<sup>20</sup>. Those findings also indicate the extended implications to the hospital infection prevention guidelines, with a strong focus on the multidisciplinary collaboration among the surgeons, anesthetists, and infection control teams<sup>21</sup>. Additionally, the implant type was not statistically significant, but differences in surface properties or material bioactivity still have the potential to affect bacteria attachment as it has been noted in mechanistic experiments<sup>22,23</sup>. The clinical implications of such findings imply that a reduction in the burden of postoperative infections and the health care cost can be achieved by maximizing the ability of modifiable risk factors<sup>24,25</sup>.

This study has a number of limitations. It has a single-center design which might not be generalizable to larger populations. Causal inference is limited by the cross-sectional nature also. Moreover, microbiological characterization of the infecting organisms was not provided, which might have been a valuable input to the study with regards to the pattern of antibiotic resistance. The prospective studies in the future must use multicentric design and extended follow-up to determine the trends of infections and the microbial profiles. Future research that includes the use of molecular diagnosis would enhance the early diagnosis and focused treatment of implant-related infections.

### CONCLUSION

This research has shown that surgical site infections after orthopedic implant surgeries continue to be a major complication in the postoperative care, with an occurrence of 11.7%. The main independent risk factors were diabetes mellitus, smoking, long surgical time, and absence of antibiotic prophylaxis. These results underscore the need to inhibit adjustable patients- and procedure-related conditions to minimize the risk of SSI. Additional multicentric research are required to confirm these findings and improve infection control measures.

### FUNDING

None.

### CONFLICT OF INTEREST

None.

### ETHICAL APPROVAL

This descriptive cross-sectional study (April 2024 to July) enrolled 180 patients aged 18 years and above who were undergoing orthopedic implant surgeries (Ref: 2256/AST/2024) from the departments of surgery, ASMC Lahore and AIMH Gujranwala followed by an informed consent

### AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

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