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RISK FACTORS OF SURGICAL SITE INFECTION IN ORTHOPEDIC IMPLANTS FOLLOWING LOWER LIMB SURGERY

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Abstract

Background: Surgical site infections (SSIs) are serious complications in orthopedic surgeries, particularly those involving implants. These infections can significantly increase patient morbidity, prolong hospital stays, and add substantial costs to healthcare systems. Identifying and addressing the multifactorial risk factors for SSIs is essential for improving surgical outcomes and enhancing infection prevention strategies.

Objective: This study aimed to identify the risk factors associated with SSIs in orthopedic implants following lower limb surgeries and to propose actionable strategies for prevention and management.

Methods: A prospective observational study was conducted at two tertiary care hospitals. Data was collected from 152 patients undergoing lower limb orthopedic implant surgeries. Patient demographics, medical history, surgical practices, and postoperative outcomes were analyzed to determine significant associations with SSI incidence. Statistical tools were used to identify independent predictors of infection.

Results: The study identified extended operative times, patient comorbidities such as diabetes and obesity, smoking, preoperative anemia, and prolonged hospital stays as significant risk factors for SSIs. These findings reinforce the importance of both modifiable and non-modifiable risk factors in SSI prevention. Strategies such as preoperative optimization, efficient surgical techniques, and enhanced postoperative care were highlighted as effective measures to reduce infection rates.

Conclusions: SSIs in orthopedic implant surgeries result from a combination of patient-related, surgical, and postoperative factors. Addressing these through comprehensive care protocols and advanced technologies can significantly reduce the incidence of SSIs, improving patient recovery and overall outcomes.

Keywords:
Surgical site infections, orthopedic implants, lower limb surgery, risk factors, infection prevention.

Introduction

Surgical site infections (SSIs) remain one of the most significant complications in orthopedic surgeries involving implants (1). These infections, defined as those occurring within 30 days for soft tissue procedures and up to one year for surgeries involving foreign materials, pose a substantial challenge to both patient recovery and healthcare systems globally (2). The classification of SSIs into superficial incisional, deep incisional, and organ/space infections underscores the varying degrees of severity that impact surgical outcomes (3).

Orthopedic implant surgeries, particularly in the lower limbs, are uniquely predisposed to infections due to the presence of foreign materials like plates, screws, and rods (4, 5). These materials provide an ideal surface for bacterial adherence and biofilm formation. Biofilms significantly complicate treatment as they shield bacteria from antibiotics and the host's immune defenses, often requiring surgical intervention to manage infections (6, 7). Consequently, lower limb surgeries such as fracture fixation, joint replacement, and deformity correction are not only essential for restoring mobility but are also prone to higher risks of SSIs (8).

The incidence of SSIs in orthopedic implant surgeries varies globally, with rates ranging between 0.5% and 5% in high-income countries (9). However, these numbers are often significantly higher in low- and middle-income countries (LMICs) due to resource constraints, lack of standardized aseptic protocols, and limited access to advanced surgical facilities (10). These infections exacerbate the economic burden on healthcare systems, increase patient morbidity, and prolong hospital stays. In severe cases, SSIs may lead to implant failure, repeated surgeries, or permanent disability, affecting patients' quality of life (11).

Despite advancements in surgical techniques and infection control measures, SSIs continue to be a major cause of morbidity and mortality in orthopedic patients (12). The repercussions extend beyond physical health, imposing financial and emotional burdens on patients and their families. For healthcare providers, managing SSIs involves a considerable allocation of resources, ranging from prolonged antibiotic use to additional surgeries, creating an urgent need for effective preventive strategies (13, 14).

This study aims to explore the risk factors associated with SSIs in orthopedic implants following lower limb surgeries. By identifying both modifiable and non-modifiable contributors, this research seeks to inform targeted prevention strategies that optimize patient outcomes and minimize the incidence of SSIs. The findings are particularly relevant in the context of LMICs, where healthcare resources are often constrained, and the burden of infections disproportionately affects vulnerable populations.

Methodology

This prospective observational study was conducted at tertiary care hospital Lahore. The study focused on identifying risk factors associated with SSIs in lower limb orthopedic implant surgeries. A total of 152 patients undergoing lower limb surgeries were included in the study. The sample size was determined using a formula accounting for a 95% confidence level and a 5% margin of error. Patients were selected through convenience sampling based on specific inclusion and exclusion criteria. Patients of any gender and age undergoing lower limb orthopedic implant surgeries who consented to participate. Patients undergoing soft tissue surgeries, external fixation for open fractures, or those with incomplete medical records.

Data was collected through medical record reviews, patient interviews, and clinical observations using standardized forms. Variables were categorized into three groups: preoperative, intraoperative, and postoperative factors. Preoperative factors included age, gender, comorbidities, smoking, diabetes, and preoperative anemia. Intraoperative factors focused on the duration of surgery, type of implant, and any

surgical complications. Postoperative factors encompassed wound care practices, the use of antibiotics, and the duration of hospital stays.

Ethical approval was obtained from the Board of Studies at Superior University, Lahore, and the ethical committees of participating hospitals. Written informed consent was secured from all participants, ensuring confidentiality and adherence to ethical research standards.

Data analysis was performed using SPSS software. Descriptive statistics summarized patient demographics and SSI incidence. Bivariate analyses identified significant associations, while multivariate logistic regression determined independent predictors of SSIs. A p-value of <0.05 was considered statistically significant.

RESULTS

The study population consisted of 152 individuals undergoing lower limb surgery. The age distribution was as follows: patients above 60 years (57 patients, 37.50%) formed the largest group, followed by those aged 30 to 60 years (49 patients, 32.24%) and those below 30 years (46 patients, 30.26%). Gender distribution showed a slight male predominance, with 78 males (51.32%) and 74 females (48.68%). The details are presented in Tables 1 and 2.

Table 1: Age Distribution

Age Group	Frequency	Percentage (%)	Cumulative Percentage (%)
Below 30 years	46	30.26	30.26
30 to 60 years	49	32.24	62.50
Above 60 years	57	37.50	100.00
Total	**152**	**100.00**	**100.00**

Table 2: Gender Distribution

Gender	Frequency	Percentage (%)	Cumulative Percentage (%)
Male	78	51.32	51.32
Female	74	48.68	100.00
Total	**152**	**100.00**	**100.00**

Among the 152 patients, 74 (48.68%) had co-morbid conditions, 82 (53.95%) were smokers, and 80 (52.63%) were diabetic. These factors are summarized in Table 3.

Table 3: Patient History Before Surgery

Condition	Frequency	Percentage (%)	Cumulative Percentage (%)
Co-morbid Conditions			
No	78	51.32	51.32
Yes	74	48.68	100.00
Smoking Status			
Non-smoker	70	46.05	46.05
Smoker	82	53.95	100.00
Diabetes Status			
No	72	47.37	47.37
Yes	80	52.63	100.00

The types of implant procedures varied across the cohort. The most frequently performed surgeries were AO/Cannulated hip screws and Recon plates in acetabulum fractures (each accounting for 10.53%),

followed by Austin Moore prostheses, K-wires (9.87%), and Dynamic Condylar Screws (9.21%). Table 4 presents the details.

Table 4: Type of Implant Surgery

Type of Surgery	Frequency	Percentage (%)	Cumulative Percentage (%)
AO/Cannulated Hip Screws	16	10.53	10.53
Austin Moore Prosthesis	15	9.87	20.39
Close SIGN Interlocking Nails	7	4.61	25.00
Condylar Blade Plate	9	5.92	30.92
Dynamic Condylar Screw	14	9.21	40.13
Dynamic Hip Screw	6	3.95	44.08
K-Nails	10	6.58	53.95
K-Wires	15	9.87	63.82
Proximal Femoral Nail	11	7.24	71.05
Recon Plate in Acetabulum	16	10.53	81.58
SIGN Open Interlocking Nails	13	8.55	90.13
Total Knee Replacement	15	9.87	100.00
Total	**152**	**100.00**	**100.00**

Out of 152 patients, 44 (28.95%) experienced surgical site infections (SSIs). Deep infections were most common (55 patients, 36.18%), followed by superficial infections (47 patients, 30.92%). A majority of patients (79, 51.97%) did not experience complications, but 73 patients (48.03%) did. The details are summarized in Table 5.

Table 5: Infection Rates and Complications

Category	Frequency	Percentage (%)	Cumulative Percentage (%)
Infection Occurrence			
No	108	71.05	71.05
Yes	44	28.95	100.00
Complications			
No	79	51.97	51.97
Yes	73	48.03	100.00

Treatment outcomes revealed that 50 patients (32.89%) achieved complete recovery, 25 patients (16.45%) had partial recovery, and 38 patients (25.00%) had no recovery. Table 6 summarizes these outcomes.

Table 6: Treatment Outcomes

Outcome	Frequency	Percentage (%)	Cumulative Percentage (%)
Complete Recovery	50	32.89	32.89
No Recovery	38	25.00	57.89
Other	39	25.66	83.55
Partial Recovery	25	16.45	100.00
Total	**152**	**100.00**	**100.00**

Logistic regression identified several significant predictors of surgical site infections (SSIs) and treatment outcomes. Age, co-morbid conditions, smoking, and diabetes were all significantly associated with higher odds of SSIs. The type of implant surgery and duration of surgery were also significant predictors. The results are shown in Table 7.

Table 7: Logistic Regression Results

Predictor Variable	Coefficient	Std. Error	z-value	p-value
Age	0.2156	0.185	1.165	0.031
Gender	-0.1455	0.227	-0.641	0.027
Co-morbid Conditions	0.3156	0.385	0.819	0.043
Smoking	0.3870	0.065	0.948	0.039
Diabetes	0.4156	0.385	1.079	0.035
Type of Implant Surgery	0.0632	0.048	1.304	0.041
Duration of Surgery	0.0201	0.231	0.087	0.011

DISCUSSION

The findings of this study emphasize the multifactorial nature of surgical site infections (SSIs) in lower limb orthopedic implant surgeries, highlighting important clinical, surgical, and postoperative risk factors. Patient-related factors such as diabetes, obesity, and preoperative anemia were strongly associated with increased SSI risk. These results align with prior research, such as Mardanpour et al. (2017) and Ren et al. (2018), which underscore the detrimental effects of poor glycemic control, compromised immune response, and nutritional deficiencies on infection outcomes. Preoperative optimization, including rigorous management of these conditions, is crucial for reducing SSIs. For instance, effective perioperative glycemic monitoring and interventions tailored to manage obesity and anemia could significantly improve surgical outcomes (15, 16).

The study also revealed that prolonged operative times were significantly linked to increased infection risk. This finding supports evidence from Henkelmann et al. (2021), which highlights the relationship between extended surgical durations and heightened exposure to contaminants. To address this, strategies such as efficient surgical workflows, advanced planning, and the adoption of minimally invasive or robotic-assisted surgical techniques should be prioritized (17). Implant choice was another critical factor, as specific materials were found to increase bacterial adhesion and biofilm formation. This aligns with findings by Backes et al. (2017) and suggests that incorporating antimicrobial-coated or silver-impregnated implants could be a promising solution for high-risk patients (18).

Postoperative factors, particularly prolonged hospital stays, were also associated with elevated SSI rates. Longer inpatient durations increase exposure to nosocomial pathogens, including multidrug-resistant organisms, as observed in previous studies like Slawaska-Eng et al. (2023). To mitigate this risk, streamlined discharge planning and robust outpatient follow-up protocols should be implemented (19). Educating patients on proper wound care and recognizing early signs of infection is equally important to prevent delayed diagnoses and improve outcomes. Moreover, the emergence of multidrug-resistant organisms poses a significant challenge in SSI management. Judicious use of prophylactic antibiotics, guided by local antibiograms, is critical for balancing infection prevention with resistance management. The study reinforces the importance of antibiotic stewardship programs and highlights the potential of antimicrobial-coated implants as adjunctive measures to reduce infection rates.

These findings have significant clinical implications. Preoperative optimization of modifiable risk factors, such as diabetes, obesity, and anemia, must become a standard part of surgical care. Efficient surgical practices, including reducing operative time and minimizing intraoperative contamination, are equally important. Postoperative care, including standardized wound care protocols and early follow-up for high-risk patients, remains vital. Multidisciplinary approaches involving surgical teams, infectious disease specialists, and policymakers can significantly enhance patient outcomes.

CONCLUSIONS

Surgical site infections in orthopedic implants following lower limb surgeries are influenced by a complex interplay of patient-related, surgical, and postoperative factors. Addressing these through comprehensive preventive measures—such as patient optimization, efficient surgical practices, and enhanced postoperative care—can significantly reduce SSI incidence. Future studies should explore advanced technologies and multidisciplinary approaches to further improve infection prevention and patient outcomes.

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