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Research Article

Study of Surgical Site Infections in Implant Surgeries: Risk Factors and Microbiological Profile

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ABSTRACT
Introduction: Surgical Site Infections (Ssis) Are A Major Postoperative Complication In Orthopedic Procedures, Particularly Those Involving Implants. They Contribute To Increased Morbidity, Prolonged Hospitalization, and Higher Healthcare Costs. Understanding The Risk Factors And Microbiological Profile Of Ssis Is Essential For Effective Prevention And Management.
Aim: To Study Surgical Site Infections In Orthopedic Patients With Reference To Demographic Characteristics, Risk Factors, Microbiological Profile, And Clinical Outcomes.
Methods: A Prospective Case-Control Study Was Conducted Over 12 Months In The Department Of Orthopaedics. Group An Included 50 Patients Who Developed SSI Following Surgery, While Group B Comprised 50 Age-, Sex-, Procedure-, And Surgeon-Matched Controls Without SSI. Data On Demographics, Comorbidities, Surgical Parameters, And Outcomes Were Collected. Microbiological Analysis Of Wound Cultures Was Performed, And Statistical Comparisons Were Made Using Chi-Square And T-Tests.
Results: SSI Cases Had A Higher Prevalence of Diabetes (38%), Smoking (42%), Obesity (30%), Prolonged Surgery (>2 Hrs, 56%), and Extended Preoperative Hospital Stay (>3 Days, 48%) Compared To Controls (P<0.05). Staphylococcus Aureus Was the Most Common Isolate (MSSA 28%, MRSA 22%), Followed By Pseudomonas Aeruginosa (14%) And Klebsiella Spp. (10%). SSI Patients Had Significantly Longer Hospital Stays (14.2 ± 4.6 Days), Higher Reoperation Rates (26%), And Increased Readmissions (22%) Compared To Controls (P<0.001).
Conclusion: Ssis In Orthopedic Implant Surgeries Are Associated With Identifiable Risk Factors And A Predominance Of Multidrug-Resistant Organisms. Early Recognition And Targeted Interventions Are Critical To Improving Surgical Outcomes And Reducing Infection-Related Morbidity.

Keywords: Surgical Site Infection (Ssi); Orthopedic Implants.

INTRODUCTION

Surgical site infections (SSIs) represent a significant challenge in orthopedic practice, particularly in procedures involving implants. These infections are not only a source of considerable patient morbidity but also contribute to prolonged hospitalization, increased healthcare costs, and compromised functional outcomes. The burden of SSI is magnified in orthopedic surgery due to the frequent use of foreign materials, such as plates, screws, and prostheses, which can serve as niduses for microbial colonization and biofilm formation[1]. Globally, the incidence of SSI in orthopedic procedures ranges from 2% to 8%, with higher rates reported in resource-limited settings[2]. The pathogenesis of SSI is multifactorial, involving host-related factors (e.g., diabetes, obesity, smoking), procedural variables (e.g., duration of surgery, use of implants), and microbial characteristics[3]. The emergence of multidrug-resistant organisms, especially methicillin-resistant *Staphylococcus aureus* (MRSA), has further complicated treatment protocols and necessitated the use of broad-spectrum or reserve antibiotics[4]. Despite advances in surgical technique and infection control, SSIs continue to pose a threat to patient safety and surgical success. Understanding the demographic profile, identifying modifiable risk factors, and characterizing the microbiological spectrum of SSI are essential for developing targeted preventive strategies and optimizing postoperative care[5]. This study aims to address these aspects by comparing SSI cases with matched controls in a tertiary orthopedic setting.

Aims and Objectives

Aim

To study surgical site infections in orthopedic patients with a focus on risk factors, microbiological profile, and clinical outcomes.

Objectives

1. To compare demographic variables (age, gender) between SSI cases and matched controls.
2. To identify and analyze risk factors associated with SSI.
3. To determine the microbiological profile of SSI in orthopedic implant surgeries.
4. To assess clinical outcomes including hospital stay, reoperation, and readmission rates.

MATERIALS AND METHODS

- **Study Design**

A prospective, observational case-control study conducted in the Department of Orthopaedics over a 12-month period.

- **Study Population**

a. **Group A (Cases):** 50 patients who developed SSI (clinically or microbiologically confirmed) following orthopedic surgery.
b. **Group B (Controls):** 50 age-, sex-, procedure-, and surgeon-matched patients who underwent similar orthopedic surgeries without developing SSI.

- **Inclusion Criteria**

1. Patients aged ≥18 years.
2. Underwent orthopedic surgery with or without implant.
3. For cases: SSI diagnosed based on CDC criteria within 30 days postoperatively or within 1 year if implant was used.

- **Exclusion Criteria**

1. Patients with pre-existing infections at the surgical site.
2. Immunocompromised patients (e.g., HIV, chemotherapy).
3. Lost to follow-up within 30 days post-surgery.

- **Data Collection**

Demographic data, comorbidities, surgical details, and postoperative outcomes were recorded. Pus or wound swabs were cultured using standard microbiological techniques. Antibiotic susceptibility was determined using CLSI guidelines.

- **Statistical Analysis**

Statistical analysis was performed using SPSS software, version 20. Data are expressed as mean ± SD and frequency with percentages N (%). Chi-square and t-tests were used to compare categorical and continuous variables, respectively. A p-value <0.05 was considered statistically significant.

OBSERVATION AND RESULT

Table 1: Demographic Variables

Sr No	Variables	Group A (Ssi Cases, N=50)	Group B (Controls, N=50)	Total
1	Age (Years)			
	a. <30 Years	6 (12%)	7 (14%)	13 (13 %)
	b. 30–50 Years	23 (46%)	25 (50%)	48 (48 %)
	c. >50 Years	21 (42%)	18 (36%)	39 (39 %)
	Mean ± Sd	48.6 ± 14.2	46.9 ± 13.7	-
2	Gender			
	a. Male	33 (66%)	32 (64%)	65 (65 %)
	b. Female	17 (34%)	18 (36%)	35 (35 %)

The age distribution among SSI cases (Group A) and matched controls (Group B) was comparable, with a mean age of 48.6 ± 14.2 years in Group A and 46.9 ± 13.7 years in Group B. Most participants were between 30–50 years of age, accounting for 46% in Group A and 50% in Group B. Patients aged over 50 years comprised 42% of cases and 36% of controls, while those under 30 years were least represented (12% vs. 14%). Gender distribution was also similar across groups, with males constituting 66% of SSI cases and 64% of controls. Females accounted for 34% of cases and 36% of controls. These findings suggest that age and gender were well matched between groups and are unlikely to have confounded the observed differences in SSI outcomes.

Table 2: Risk Factors Associated With SSI

Sr No	Risk Factor	Group A (Ssi Cases, N=50)	Group B (Controls, N=50)	P-Value
1	Diabetes Mellitus	19 (38%)	9 (18%)	0.01
2	Smoking	21 (42%)	10 (20%)	0.008
3	Obesity (Bmi >30)	15 (30%)	8 (16%)	0.04
4	Duration Of Surgery >2 Hrs	28 (56%)	14 (28%)	0.003
5	Use Of Implants	36 (72%)	35 (70%)	0.81
6	Preoperative Hospital Stay >3 Days	24 (48%)	13 (26%)	0.02
7	Asa Score ≥3	18 (36%)	9 (18%)	0.03

Several risk factors were significantly more prevalent among SSI cases compared to controls. Diabetes mellitus was present in 38% of cases versus 18% of controls (p=0.01), indicating a strong association with postoperative infection. Smoking was reported in 42% of cases compared to 20% of controls (p=0.008), reinforcing its role as a modifiable risk factor. Obesity (BMI >30) was observed in 30% of cases and 16% of controls (p=0.04), suggesting that higher BMI may predispose to SSI. Prolonged surgical duration (>2 hours) was significantly more common in cases (56%) than controls (28%) (p=0.003), highlighting the importance of operative time in infection risk. Preoperative hospital stay exceeding 3 days was noted in 48% of cases versus 26% of controls (p=0.02), and ASA score ≥3 was present in 36% of cases compared to 18% of controls (p=0.03). These findings underscore the contribution of systemic comorbidities and perioperative factors to SSI development. Use of implants was similar in both groups (72% vs. 70%, p=0.81), suggesting that implant presence alone may not be a differentiating factor in this cohort.

Table 3: Microbiological Profile of SSI

Sr No	Isolate Identified	Group A (Ssi Cases, N=50)	Group B (Controls, N=50)	Antibiotic Resistance Profile
1	Staphylococcus Aureus (Mssa)	14 (28%)	0 (0%)	Sensitive To Cefazolin, Clindamycin
2	Staphylococcus Aureus (Mrsa)	11 (22%)	0 (0%)	Resistant To Beta-Lactams; Sensitive To Vancomycin
3	Pseudomonas Aeruginosa	7 (14%)	0 (0%)	Resistant To Ceftazidime; Sensitive To Meropenem
4	Klebsiella Spp.	5 (10%)	0 (0%)	Esbl-Producing; Sensitive To Carbapenems
5	Escherichia Coli	4 (8%)	0 (0%)	Esbl-Producing; Sensitive To Amikacin
6	Polymicrobial	3 (6%)	0 (0%)	Mixed Resistance Profiles
7	Culture Negative	6 (12%)	0 (0%)	—

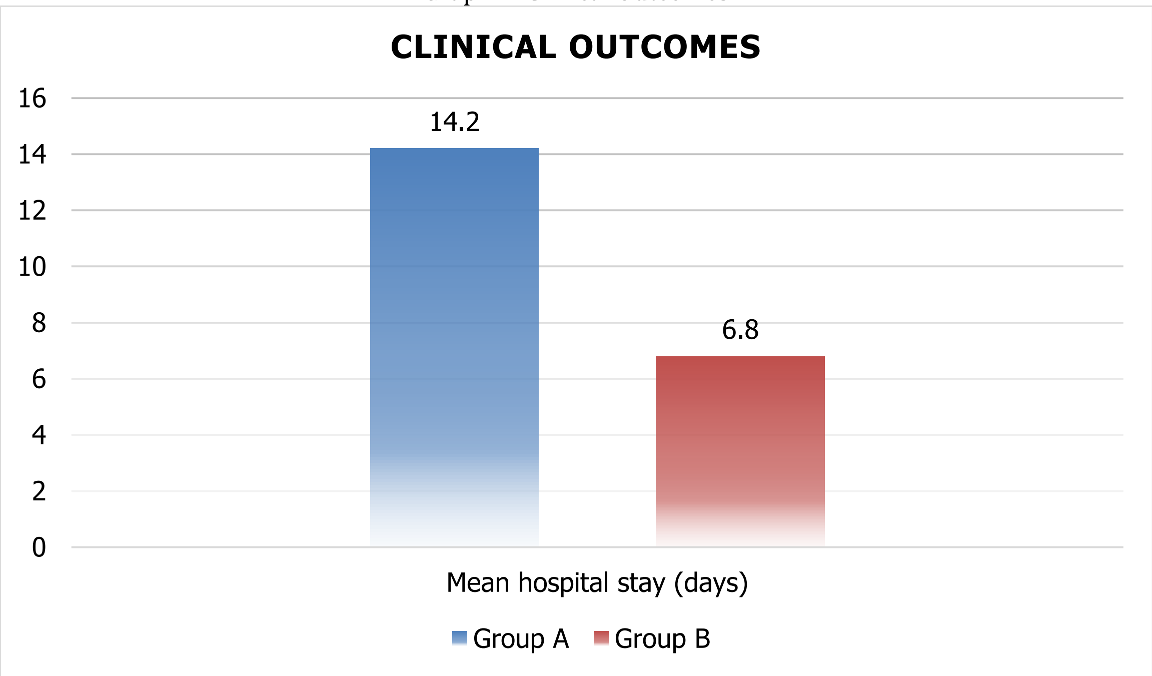
Among the 50 SSI cases, the most frequently isolated pathogen was Staphylococcus aureus, with 14 cases (28%) due to methicillin-sensitive strains (MSSA) and 11 cases (22%) due to methicillin-resistant strains (MRSA). MRSA isolates exhibited resistance to beta-lactams but remained sensitive to vancomycin, while MSSA strains were susceptible to cefazolin and clindamycin. Gram-negative organisms were also prominent, including Pseudomonas aeruginosa (14%), Klebsiella spp. (10%), and Escherichia coli (8%). These isolates demonstrated extended-spectrum beta-lactamase (ESBL) production and were sensitive to carbapenems and aminoglycosides. Polymicrobial infections were identified in 6% of cases, and 12% of samples yielded no growth despite clinical signs of infection. No organisms were isolated from control participants, affirming the specificity of microbiological findings to SSI cases.

Table 4: Clinical Outcomes

Sr No	Outcome Variable	Group A (Ssi Cases, N=50)	Group B (Controls, N=50)	P-Value
1	Mean Hospital Stay (Days)	14.2 ± 4.6	6.8 ± 2.1	<0.001
2	Reoperation Required	13 (26%)	1 (2%)	<0.001
3	Wound Dehiscence	9 (18%)	0 (0%)	<0.001
4	Delayed Ambulation	17 (34%)	5 (10%)	0.002
5	Readmission Within 30 Days	11 (22%)	2 (4%)	0.001

SSI cases experienced significantly worse clinical outcomes compared to controls. The mean hospital stay was more than double in Group A (14.2 ± 4.6 days) versus Group B (6.8 ± 2.1 days) ($p<0.001$). Reoperation was required in 26% of cases compared to only 2% of controls ($p<0.001$), reflecting the burden of surgical complications. Wound dehiscence occurred in 18% of cases and was absent in controls ($p<0.001$). Delayed ambulation was reported in 34% of cases versus 10% of controls ($p=0.002$), and readmission within 30 days was significantly higher in the SSI group (22% vs. 4%, $p=0.001$). These findings highlight the substantial impact of SSI on postoperative recovery, resource utilization, and patient morbidity.

Graph 1: Clinical Outcomes



DISCUSSION

The present study highlights several important findings regarding SSI in orthopedic implant surgeries. Demographically, the mean age of SSI cases (48.6 years) was comparable to controls (46.9 years), with a male predominance in both groups. This aligns with the demographic trends reported by Srivastava et al., where middle-aged males constituted the majority of SSI cases[6]. The age distribution suggests that while age itself may not be a direct risk factor, it may interact with comorbidities such as diabetes and obesity, which are more prevalent in older adults. Risk factor analysis revealed statistically significant associations between SSI and diabetes mellitus (38% vs. 18%), smoking (42% vs. 20%), and obesity (30% vs. 16%). These findings are consistent with those of Rajpurohit et al., who identified metabolic and lifestyle-related factors as key contributors to postoperative infections[7]. Prolonged surgical duration (>2 hours) and extended preoperative hospital stay (>3 days) were also significantly associated with SSI, corroborating the observations of Kanhekar et al., who emphasized the role of procedural delays and hospital-acquired colonization in infection risk[8]. Microbiologically, Staphylococcus aureus was the predominant pathogen, accounting for 50% of isolates, with MRSA comprising 22%. This is in line with global surveillance data and studies by Chua et al., which underscore the dominance of S. aureus in orthopedic SSIs[9]. The presence of gram-negative organisms such as Pseudomonas aeruginosa, Klebsiella spp. and E. coli reflects a polymicrobial etiology in a subset of cases, particularly in patients with prolonged hospitalization or prior antibiotic exposure. Kandila et al. reported similar microbial diversity in their study of orthopedic infections in sub-Saharan Africa[10]. Clinical outcomes were markedly worse in the SSI group, with significantly longer hospital stays (14.2 vs. 6.8 days), higher reoperation rates (26% vs. 2%), and increased readmissions (22% vs. 4%). These findings mirror those of Salia et al., who documented the economic and functional burden of SSI in orthopedic patients[11]. The absence of wound dehiscence and reoperation in controls further reinforces the impact of infection on surgical recovery. Overall, the study underscores the multifactorial nature of SSI and the need for comprehensive perioperative strategies, including glycemic control, smoking cessation, weight optimization, and strict adherence to aseptic protocols.

CONCLUSION

Surgical site infections in orthopedic implant surgeries are associated with identifiable risk factors such as diabetes, smoking, obesity, prolonged surgery, and extended preoperative stay. Staphylococcus aureus, particularly MRSA, remains the leading pathogen, with a notable contribution from multidrug-resistant gram-negative organisms. Early identification of high-risk patients and adherence to infection control protocols are essential to reduce SSI incidence and improve postoperative outcomes.

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