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INCIDENCE AND RISK FACTORS OF SURGICAL SITE INFECTION ASSOCIATED WITH LUMBAR SPINE SURGERY IN UPPER SINDH

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ABSTRACT
Surgical site infections (SSIs) are a serious complication of lumbar spine surgery. This prospective study evaluated 600 patients undergoing lumbar spine procedures at a tertiary hospital in Upper Sindh (Jan 2018–Dec 2024). We determined the SSI incidence and analyzed patient and surgical factors associated with infection. Overall SSI incidence was 7.5% (45/600). Patients with SSIs were significantly older and had higher rates of obesity (BMI≥30), diabetes, and smoking. Univariate analysis showed that age, obesity, diabetes, smoking, longer operative time, and more blood loss were associated with SSIs. Multivariate logistic regression identified the following independent risk factors: advanced age (OR=1.03 per year, 95% CI 1.01–1.05), obesity (OR=2.50, 95% CI 1.30–4.80), diabetes (OR=2.40, 95% CI 1.30–4.50), smoking (OR=2.10, 95% CI 1.10–4.20), increased operative time (OR=1.50 per hour, 95% CI 1.20–1.90), higher intraoperative blood loss (OR=1.002 per mL, 95% CI 1.001–1.003), and use of spinal implants (OR=3.00, 95% CI 1.20–7.50). These findings point out that modifiable patient factors (weight, glycemic control, smoking), perioperative management (minimizing surgery duration and blood loss), and proper post-operative care are critical to reducing SSI risk. Interventions targeting these factors may improve outcomes.
Keywords: *surgical site infection; lumbar spine surgery; risk factors; incidence; prospective study*

INTRODUCTION
Surgical site infection (SSI) is a significant source of morbidity in spine surgery. SSIs account for roughly 31% of all hospital-acquired infections and represent the most common infections treated by spinal surgeons[1]. SSI rates vary by procedure invasiveness and patient population, ranging from about 0.07% in simple anterior cervical operations up to 12.2% in complex revision lumbar fusions[2]. Even with modern prophylaxis and sterile techniques, SSIs can occur and often require surgical debridement, leading to prolonged hospital stay, higher costs, and adverse patient outcomes[3]. For example, SSI after spine surgery has been estimated to prolong hospitalization by 9.7 days and add roughly $20,842 in costs per patient. In a single-center study, Blumberg et al. reported an average direct treatment cost of $16,242 per SSI case. Infected patients also have poor outcomes[4]. Petilon **et al. (2012)**[5] found that patients with deep SSI after instrumented fusion reported significantly more back pain and were less likely to achieve meaningful functional improvement in two

years compared to uninfected patients. Importantly, SSIs have been linked to increased mortality following spine surgery[5]. A recent matched cohort analysis showed that five-year mortality was 15.5% in patients with SSI versus only 3.4% in controls[6]. These findings highlight the clinical and economic burden of SSIs and the need for effective prevention.

Prior studies have identified numerous risk factors for SSI in spinal surgery. Patient-related factors such as advanced age, obesity, diabetes mellitus, and tobacco use have been implicated[7]. A meta-analysis by Zhang and Li (2018) reported diabetes (RR=2.2) and obesity (RR=2.9) as significant predictors of SSI after lumbar surgery. Smoking has also been linked to higher SSI risk (meta-estimated OR=1.26). Surgical factors such as longer operative duration, more blood loss, multilevel fusion, and the use of instrumentation have likewise been associated with infection risk[8]. However, the relative importance of these factors can vary by population and practice setting. Data on SSI incidence and risk factors specific to Pakistan are limited, and no prior study has focused on the Upper Sindh region.

Accordingly, this study aimed to determine the incidence of SSIs among patients undergoing lumbar spine surgery in Upper Sindh, and to identify associated patient and perioperative risk factors. Specifically, we assessed how demographic factors (age, gender, BMI), clinical variables (diabetes, smoking, operative time, blood loss, use of implants, etc.), and post-operative care relate to SSI occurrence. Understanding these associations can inform targeted preventive strategies in this setting.

Methods

A prospective study was performed at Department of Neurosurgery, KMC Hospital Khairpur and PUMHS Nawabshah from January 2018 to December 2024 in Upper Sindh. The institutional review board approved the study protocol, and all data was identified. The Inclusion criteria was patients ≥18 years old who underwent lumbar spine surgery. Patients were required to have complete medical records and at least 30 days of postoperative follow-up. Exclusion criteria included surgery for acute trauma or tumor, incomplete records, or lost follow-up. Data was obtained by using a standardized form. Collected variables included patient demographics (age, gender, body mass index [BMI]), comorbidities (diabetes, smoking status, **etc.**), surgical details (operative duration, estimated blood loss, use of instrumentation), and outcomes (SSI occurrence within 30 days). SPSS v25 was used to analyze the data. Initially mean was done later univariate and multivariate were done. Variables with $p<0.05$ in univariate analysis were entered into a multivariate logistic regression model to identify independent predictors of SSI. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated.

Results

This study explained Out of 600 patients, 45 developed a surgical site infection (SSI), yielding an overall incidence of **7.5**%. Table No. 01 summarizes demographic and clinical characteristics by SSI status. Patients with SSI were older (mean age 59.2 ± 13.3 years) than those without SSI (52.4 ± 14.7 years). Obesity (BMI ≥30) was more frequent in the SSI group (25/45, 55.6%) than in the non-SSI group (190/555, 34.2%). Similarly, diabetes mellitus was present in 44.4% of SSI patients versus 21.6% of non-SSI patients, and 33.3% of SSI patients were current smokers (vs 15.3% in the non-SSI group). Gender distribution was comparable between groups. These findings suggest that patients who developed SSI had a higher burden of comorbid risk factors.

Table No 01. Demographic characteristics of the study population (SSI vs. no SSI).

Characteristic	No SSI (n=555)	SSI (n=45)	Total (n=600)
Mean age (years)	52.4 ± 14.7	59.2 ± 13.3	52.8 ± 14.6
Male, n (%)	310 (55.9%)	25 (55.6%)	335 (55.8%)
Female, n (%)	245 (44.1%)	20 (44.4%)	265 (44.2%)
BMI ≥ 30 kg/m², n (%)	190 (34.2%)	25 (55.6%)	215 (35.8%)
Diabetes mellitus, n (%)	120 (21.6%)	20 (44.4%)	140 (23.3%)

Current smoker, n (%)	85 (15.3%)	15 (33.3%)	100 (16.7%)

Univariate comparisons (Table No.02) confirmed that advanced age, obesity, diabetes, and smoking were significantly associated with SSI. The mean age difference between SSI and non-SSI groups was statistically significant ($p<0.001$), and higher proportions of SSI patients had BMI≥30, diabetes, and smoking history (all $p<0.01$).

Table No. 02. Univariate analysis of patient-related risk factors for SSIs.

Risk Factor	No SSI (n=555)	SSI (n=45)	p-value
Mean age (years)	52.4 ± 14.7	59.2 ± 13.3	< 0.001
BMI ≥ 30 kg/m², n (%)	190 (34.2%)	25 (55.6%)	0.002
Diabetes mellitus, n (%)	120 (21.6%)	20 (44.4%)	0.001
Current smoker, n (%)	85 (15.3%)	15 (33.3%)	0.003

Surgical and perioperative factors are shown in Table No. 03. Patients who developed SSIs had a significantly longer operative time (mean 3.4 ± 1.5 hours vs 2.5 ± 1.1 hours for non-SSI; $p<0.001$) and greater blood loss (mean 700 ± 250 mL vs 500 ± 200 mL; $p<0.001$). The use of spinal instrumentation was more common in the SSI group (88.9%) than in controls (63.1%, p=0.002).

Table No. 03. Univariate analysis of surgical and perioperative risk factors for SSIs.

Risk Factor	No SSI (n=555)	SSI (n=45)	p-value
Operative time (hours)	2.5 ± 1.1	3.4 ± 1.5	< 0.001
Intraoperative blood loss (mL)	500 ± 200	700 ± 250	< 0.001
Use of instrumentation (implants)	350 (63.1%)	40 (88.9%)	0.002

Finally, multivariate logistic regression identified several independent predictors of SSI (Table No. 04). Each additional year of age increased the odds of infection by about 3% (OR=1.03, 95% CI 1.01–1.05, p=0.002). Obesity (BMI≥30) doubled the infection risk (OR=2.50, 95% CI 1.30–4.80, p=0.006). Diabetes was associated with 2.4% higher odds (95% CI 1.30–4.50, p=0.005), and smokers had over twice the odds of non-smokers (OR=2.10, 95% CI 1.10–4.20, p=0.022). Prolonged surgery was also an independent predictor (OR=1.50 per hour, 95% CI 1.20–1.90, $p<0.001$), as was increased blood loss (OR=1.002 per mL, 95% CI 1.001–1.003, $p<0.001$). Use of surgical implants carried the highest risk, tripling the odds of SSI (OR=3.00, 95% CI 1.20–7.50, p=0.017).

Table No. 04. Multivariate logistic regression analysis of risk factors for SSIs.

Risk Factor	Adjusted OR	95% CI	p-value
Age (per year)	1.03	1.01–1.05	0.002
BMI ≥ 30 kg/m²	2.50	1.30–4.80	0.006
Diabetes mellitus	2.40	1.30–4.50	0.005
Current smoker	2.10	1.10–4.20	0.022
Operative time (per hour)	1.50	1.20–1.90	< 0.001
Blood loss (per mL)	1.002	1.001–1.003	< 0.001
Use of instrumentation (implants)	3.00	1.20–7.50	0.017

Discussion

In this study, SSI incidence after lumbar spine surgery was 7.5%, which associated with previously reported ranges (0.7% to 12%)[9]. These findings highlight several patient and surgical factors that significantly influence SSI risk. Advanced age emerged as a risk factor: each additional year increased infection odds by 3%. Although some studies have not found age to be significant, these results suggest that age-related declines in immune function and wound healing may contribute to higher SSI

vulnerability in older patients[10]. Even with prior research, obesity and diabetes were strong predictors of SSI in the study. Patients with BMI≥30 had 2.5% times higher SSI odds, and diabetics had 2.4% times higher odds. Zhang and Li (2018) reported diabetes (RR=2.19) and obesity (RR=2.87) as significant SSI risk factors after lumbar surgery[8]. The metabolic impairments associated with obesity and hyperglycemia likely impair wound healing and immune response, increasing infection susceptibility[11]. Smoking was another independent risk factor (OR=2.1% in the study). This supports a meta-analysis by Kong et al. (2017) showing smokers have a significantly higher SSI risk (pooled OR =1.26%) compared to nonsmokers. Nicotine and other tobacco toxins can impair circulation and inflammatory responses, which may explain this association. Notably, some studies have yielded inconsistent results regarding smoking, possibly due to study design differences, but these findings affirm that tobacco use is an important modifiable risk factor in spinal SSI[12].
Among surgical factors, prolonged operative time and greater intraoperative blood loss both independently increased SSI risk. Longer surgery duration likely prolongs tissue exposure and operating room time, raising contamination risk, while excessive bleeding can compromise oxygen delivery to tissues and dilute immune factors. In this study multivariate analysis also showed that instrumentation use (implantation of hardware) was the most potent predictor (OR=3.0). Instrumentation may facilitate biofilm formation and reduce antibiotic penetration, as reported in other studies of spinal fusion infections[13]. Together, these results suggest meticulous surgical techniques (reducing duration and blood loss) and judicious use of implants when possible.
These results have practical implications. Preoperative optimization, including weight management, strict glycemic control, and smoking cessation should be emphasized for spine patients. Intraoperatively, surgeons should take measures to minimize operative time and blood loss, such as efficient workflow, hypotensive anesthesia, and blood-sparing techniques. Rigorous sterile techniques, perioperative antibiotics, and postoperative wound surveillance are also essential. However, the proper management of identified risk factors, may reduce incidence of SSI.

Conclusion

In whole, the incidence of surgical site infection after lumbar spine surgery in this study was 7.5%. Advanced age, obesity, diabetes, and smoking were important patient-related risk factors. Longer operative time, greater blood loss, and use of spinal instrumentation also individually increased SSI risk. These findings emphasized the need for a coordinated preventive strategy. Such as, improving patient health before surgery, and implementing intraoperative measures to mitigate infection risk. Active postoperative measures and prompt treatment of early wound issues are also critical.

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