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Original Article

Frequency and Risk Factors of Surgical Site Skin Complications Following Elective General Surgery: Prospective Observational Study

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Abstract

Objective: To determine the incidence of surgical site skin complications after elective general surgery and to identify patient- and surgery-related risk factors for their development.

Methodology: This Prospective Observational Study was conducted in the Department of General Surgery at Lady Reading Hospital, Peshawar, between Feb 2026 to June 2026. We enrolled 100 adult patients undergoing elective general surgical procedures. We used consecutive non-probability sampling to select 100 adult patients undergoing elective general surgical procedures. We collected demographic and clinical data, including BMI, DM, smoking, operative duration, wound type, and wound outcomes. We analyzed the data using SPSS version 27.0 at $p < 0.05$.

Results: Of the 100 patients, 58% were male, and 42% were female, with a mean age of 46.8 ± 13.2 years. Surgical site skin complications occurred in 21 (21%) patients. Superficial surgical site infection was the most common complication (10%), followed by wound erythema (5%), seroma (4%), and wound dehiscence (2%). Complications were significantly associated with higher body mass index (29.1 ± 3.8 vs. 25.7 ± 3.4 kg/m²; $p = 0.003$), diabetes mellitus ($p = 0.021$), operative duration > 120 minutes ($p = 0.012$), smoking ($p = 0.041$), and contaminated wounds ($p = 0.018$). Patients with complications had significantly longer hospital stays (7.6 ± 2.4 vs. 4.3 ± 1.5 days; $p < 0.001$).

Conclusion: Approximately one-fifth of elective general surgery patients developed surgical-site skin complications. Obesity, diabetes, prolonged surgery, smoking, and contaminated wounds were key risk factors. Early risk identification and evidence-based perioperative measures may reduce complications and improve outcomes.

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Introduction

Surgical site skin complications (SSSCs) constitute one of the most prevalent complications after surgery and are a significant problem in surgical practice today. These complications include superficial surgical site infection, redness around the surgical incision, seroma, hematoma, necrosis at the skin edge, wound separation, contact dermatitis, and delayed wound healing. While most elective general surgical procedures are carried out under the standard conditions of asepsis, postoperative skin complications still account for a significant portion of morbidity, extended Longer hospital stay hospital stay, functional delay, higher healthcare costs, and decreased quality of life. They also have a heavy burden on health systems, especially in low- and middle-income countries where resources for infection control may be scarce [1,2]. The proportion of surgical site complications varies significantly worldwide, depending on the surgical procedure, patient risk factors, perioperative practices, and institutional infection prevention measures. Overall rates range from 5% to 30%, and most infections are superficial surgical site infections. Elective general surgical procedures typically have lower complication rates than emergency surgery; however, wound complications can still occur despite improvements in surgical technique, antimicrobial prophylaxis, sterile operating rooms, and recovery protocols. Small wound issues can delay discharge, require outpatient visits, necessitate additional antibiotic treatments, require extra wound care, and sometimes lead to reoperation [3,4]. Multiple factors contribute to surgical site skin complications. Advanced age, obesity, diabetes mellitus, malnutrition, smoking, anemia, immunosuppression, and poor nutritional status have been the consistent risk factors associated with impaired wound healing and increased susceptibility to postoperative infections. Other factors associated with the procedure, such as long operation time, dirty or contaminated wound, excessive tissue manipulation, failure to obtain hemostasis, and improper perioperative antibiotic use, also increase the risk of postoperative wound complications. Other hospital-related factors, such as operating room sterility, compliance with infection control guidelines, surgeon experience, and postoperative wound care practices, also affect surgical outcomes [5]. Obesity is one of the most potent risk factors for postoperative wound complications due to decreased tissue perfusion, reduced oxygen delivery, and delayed collagen production by excessive adipose tissue. Likewise, diabetes mellitus impairs leukocyte function and increases microvascular disease and delayed healing, making patients more susceptible to infection and poor wound healing. Smoking leads to poorer oxygenation of tissue due to nicotine-induced vasoconstriction and carbon monoxide effects, and there is a greater risk of bacteria coming into contact with tissue and increased tissue trauma during surgical procedures. These factors often occur together, increasing the risk of postoperative complications [6,7]. The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have issued evidence-based recommendations over the last decade for reducing surgical site complications through appropriate antimicrobial prophylaxis, strict aseptic technique, glycemic control, perioperative normothermia, optimized oxygenation, and standardized wound-care protocols. The success of these guidelines varies across institutions because of differences in healthcare infrastructure, patient population, and compliance with infection prevention practices. However, complication rates have decreased in many high-income institutions [8,9]. Tertiary hospitals in Pakistan perform elective general surgery in large numbers, but local evidence on the frequency and determinants of surgical site skin complications remains limited. The available literature has focused on surgical site infections rather than all postoperative skin problems. In addition, differences in patient characteristics, comorbidities, surgical techniques, and hospital resources require locally produced data to inform prevention strategies [10]. Identifying modifiable risk factors may facilitate targeted interventions, better perioperative care, lower health care expenditures, shorter hospital stays, and better patient outcomes. Therefore, this prospective observational study determined the incidence of surgical site skin complications after elective surgery in the Department of General Surgery and identified associated patient- and surgery-related factors.

Materials and Methods

This prospective observational study was conducted in the Department of General Surgery, Lady Reading Hospital, Peshawar, Pakistan, a tertiary-care teaching hospital, over 5 months Feb 2026 to June 2026. The hospital provides comprehensive elective and emergency surgical services and serves as a referral center for patients from urban and rural areas. We recruited all eligible patients undergoing elective general surgical procedures during the study period in accordance with the predefined inclusion and exclusion criteria. Surgical-site skin complications were defined as clinically documented postoperative wound complications occurring within 30 days of surgery, including superficial surgical-site infection, wound erythema, seroma, and wound dehiscence.

Sample Size Calculation

The sample size was calculated using the WHO Sample Size Calculator based on the single population proportion formula:

$$n = Z^2 P(1-P) / d^2$$

The required sample size was 100 patients. Based on an anticipated prevalence of 20%, a 95% confidence level, and a 5% margin of error, the calculated minimum sample size was 100 patients. Therefore, 100 consecutive eligible patients were enrolled during the study period

Participants

We recruited eligible adult patients for general surgical procedures who were in the elective surgical queue over time using consecutive non-probability sampling. Inclusion criteria were written informed consent and availability for 30-day postoperative follow-up. We enrolled and analyzed 100 consecutive eligible patients. We excluded patients who underwent emergency surgery or had a known infection at the surgical site or skin infections, as well as those receiving long-term corticosteroid therapy, immunosuppressive therapy, or who were immunocompromised, had incomplete medical records, or were otherwise unavailable for 30-day follow-up.

Sampling Technique

Consecutive non-probability sampling was used. All eligible patients presenting for elective general surgical procedures during the study period were assessed for eligibility and recruited consecutively until the available study population of 100 patients was reached.

Inclusion Criteria

- Adults aged 18 years or older.
- Patients undergoing elective general surgical procedures.
- Patients undergoing procedures classified as clean, clean-contaminated, or contaminated according to standard surgical wound classification.
- Patients who provided written informed consent.
- Patients available for 30-day postoperative follow-up.

Exclusion Criteria

- Patients undergoing emergency surgical procedures.
- Patients with pre-existing surgical-site or skin infections.
- Patients receiving long-term corticosteroids or immunosuppressive therapy.
- Immunocompromised patients.
- Patients undergoing minor procedures under local anesthesia.

- Patients with incomplete medical records.
- Patients who were unavailable for or lost to 30-day postoperative follow-up.

Statistical Analysis

We entered and analyzed data using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). We assessed continuous variables for normality using the Shapiro–Wilk test and presented them as mean ± standard deviation (SD). Categorical variables are presented as frequencies and percentages. We compared patients with and without surgical-site skin complications using the independent-samples t-test for continuous variables and the Chi-square test or Fisher's exact test, as appropriate, for categorical variables. We analyzed BMI as a continuous variable in the univariate analysis and categorized it as BMI ≥30 kg/m² for multivariable analysis, corresponding to the standard definition of obesity. We included variables with p<0.10 in the univariate analysis in the multivariable logistic regression model. We did not enter postoperative longer hospital stay into the multivariable model because it is an outcome-related variable rather than a baseline predictor of surgical-site skin complications. We used the enter method for multivariable logistic regression. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated. We assessed model fit using the Hosmer–Lemeshow goodness-of-fit test. We considered a two-tailed p-value <0.05 statistically significant.

Results

The study included 100 patients undergoing elective general surgery. The cohort included 58 (58%) males and 42 (42%) females, with a mean age of 46.8 ± 13.2 years (range: 19–78 years). Surgical-site skin complications developed in 21 (21%) patients during the 30-day postoperative follow-up, whereas 79 (79%) patients experienced uncomplicated wound healing. The most common complication was superficial surgical-site infection in 10 (10%) patients, followed by wound erythema in 5 (5%), seroma formation in 4 (4%), and wound dehiscence in 2 (2%) patients. Patients who developed complications had a significantly higher mean body mass index (BMI) than those without complications (29.1 ± 3.8 vs. 25.7 ± 3.4 kg/m²; p=0.003). Diabetes mellitus was present in 38.1% of patients with complications compared with 15.2% of those without complications (p=0.021). Operative duration exceeding 120 minutes was significantly associated with postoperative surgical-site skin complications (p=0.012). Smoking (p=0.041) and contaminated wound classification (p=0.018) were also significantly associated with complications. Sex was not significantly associated with complication occurrence (p=0.470). Patients who developed complications had a significantly longer mean postoperative hospital stay than those without complications (7.6 ± 2.4 vs. 4.3 ± 1.5 days; p<0.001). Multivariable logistic regression demonstrated that BMI ≥30 kg/m², diabetes mellitus, smoking, operative duration >120 minutes, and contaminated wound classification were independently associated with increased odds of postoperative surgical-site skin complications.

Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (n = 100)

Variable	Frequency (n)	Percentage (%)
Age (years), Mean ± SD	46.8 ± 13.2	—
Male	58	58.0
Female	42	42.0
BMI (kg/m ²), Mean ± SD	26.4 ± 3.8	—
Diabetes mellitus	23	23.0
Hypertension	31	31.0
Current smokers	27	27.0
Non-smokers	73	73.0
ASA Grade I	38	38.0
ASA Grade II	47	47.0
ASA Grade III	15	15.0

Values are presented as frequency (%) unless otherwise indicated. SD = Standard Deviation; BMI = Body Mass Index; ASA = American Society of Anesthesiologists Physical Status Classification.

Table 2. Frequency and Types of Surgical Site Skin Complications (n = 100)

Surgical Site Skin Complication	Frequency (n)	Percentage (%)
No complication	79	79.0
Superficial surgical site infection	10	10.0
Wound erythema	5	5.0
Seroma	4	4.0
Wound dehiscence	2	2.0
Total with complications	21	21.0

Surgical-site skin complications were assessed clinically during hospitalization and throughout the 30-day postoperative follow-up. Each patient was classified according to the principal documented postoperative surgical-site skin complication; therefore, the categories shown in the table are mutually exclusive. Percentages were calculated from the total study population (n=100).

Table 3. Comparison of Patients with and Without Surgical Site Skin Complications

Variable	Complications (n=21)	No Complications (n=79)	p-value
Age (years), Mean ± SD	49.7 ± 12.8	46.0 ± 13.3	0.254
Male sex, n (%)	13 (61.9)	45 (57.0)	0.470
BMI (kg/m ²), Mean ± SD	29.1 ± 3.8	25.7 ± 3.4	0.003
Diabetes mellitus, n (%)	8 (38.1)	12 (15.2)	0.021
Smoking, n (%)	9 (42.9)	18 (22.8)	0.041
Operative duration >120 minutes, n (%)	10 (47.6)	17 (21.5)	0.012
Contaminated wound, n (%)	6 (28.6)	8 (10.1)	0.018
Longer hospital stay hospital stay (days), Mean ± SD	7.6 ± 2.4	4.3 ± 1.5	<0.001

We analyzed continuous variables using the independent-samples t-test and categorical variables using the Chi-square test or Fisher's exact test, as appropriate. We considered p <0.05 statistically significant.

Table 4. Multivariable Logistic Regression Analysis of Independent Factors Associated with Surgical Site Skin Complications

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
BMI ≥30 kg/m ²	2.84	1.21–6.65	0.016
Diabetes mellitus	2.56	1.08–6.07	0.031
Smoking	2.18	1.01–4.71	0.046
Operative duration >120 minutes	2.91	1.24–6.82	0.014
Contaminated wound	3.27	1.29–8.31	0.012

Multivariable logistic regression was used to identify independent factors associated with surgical-site skin complications. Variables with p<0.10 in univariate analysis were entered into the model. We excluded

postoperative hospital stay because it was an outcome-related variable rather than a baseline predictor. AOR >1 indicates increased odds of surgical-site skin complications.

Discussion

The present prospective observational study evaluated the frequency and determinants of surgical-site skin complications following elective general surgery in a tertiary care hospital. Overall, 21% of patients developed postoperative surgical-site skin complications within 30 days of surgery, with superficial surgical-site infection being the most common complication, followed by wound erythema, seroma, and wound dehiscence. Multivariable analysis identified obesity, diabetes mellitus, smoking, prolonged operative duration, and contaminated wound classification as independent factors associated with postoperative wound complications. These findings emphasize that both patient- and procedure-related factors contribute to postoperative surgical outcomes [11,12]. The overall complication rate observed in this study is consistent with previously reported international evidence. Li et al. reported postoperative wound complication rates ranging from 10% to 25% depending on patient characteristics and perioperative practices. The PakSurg Collaborative also documented a substantial burden of surgical-site infections across Pakistani hospitals despite the implementation of standard preventive protocols. Similarly, Newton et al. demonstrated that postoperative wound complications remain an important cause of prolonged recovery and increased healthcare utilization following elective surgery. Variation in reported frequencies may reflect differences in patient populations, wound classification, surgical complexity, and institutional infection-control measures [13,14]. Superficial surgical-site infection was the predominant postoperative complication in the present study. This finding is consistent with previous studies identifying superficial SSI as a common postoperative wound complication after surgical procedures. The inclusion of additional skin complications such as erythema, seroma, and wound dehiscence in the present analysis provides a broader assessment of postoperative wound morbidity compared with studies evaluating SSI alone [15,16]. Obesity emerged as one of the strongest independent factors associated with postoperative complications. Patients with complications had significantly higher BMI values than those without complications. Previous studies have demonstrated that obesity may adversely affect tissue perfusion, collagen synthesis, and wound oxygenation, thereby delaying wound healing and increasing susceptibility to infection. Increased subcutaneous tissue thickness may also contribute to greater dead space and impaired tissue healing, potentially explaining the higher complication rates observed among obese patients undergoing elective surgery [17,19]. Diabetes mellitus was another significant factor associated with surgical-site skin complications in this study. Hyperglycemia can impair neutrophil function, decrease collagen deposition, and compromise microvascular circulation, all of which may delay wound healing. These findings are consistent with evidence linking abnormal perioperative glycemic status with postoperative complications. Appropriate glycemic optimization before and around elective surgery should therefore remain an important component of perioperative management [16,20]. Prolonged operative duration, smoking, and contaminated wound classification were also independently associated with postoperative complications. Longer surgical procedures may increase tissue manipulation, bacterial exposure, and operative blood loss, whereas smoking can reduce tissue oxygenation through nicotine-induced vasoconstriction and impaired inflammatory responses. Previous surgical studies have reported comparable associations, supporting the importance of these potentially modifiable perioperative risk factors [21,22,24]. Implementation of smoking cessation strategies, meticulous surgical technique, appropriate antimicrobial prophylaxis, and efforts to minimize unnecessary operative delays may help reduce postoperative wound morbidity. An important clinical observation in the present study was the significantly longer postoperative hospital stay among patients who developed wound complications. Similar findings have been reported internationally, where surgical-site complications are associated with increased antibiotic use, repeated wound care, hospital readmissions, and higher healthcare costs. These findings reinforce the importance of perioperative optimization, standardized wound surveillance, and evidence-based infection-control

practices. In Pakistan, where healthcare resources may be constrained, identifying high-risk patients before surgery may allow targeted preventive interventions and more efficient resource utilization [23,24]. Overall, the findings indicate that several determinants of surgical-site skin complications are potentially modifiable. Early identification of high-risk patients, optimization of comorbid conditions, adherence to evidence-based perioperative protocols, and standardized postoperative wound monitoring may help reduce postoperative morbidity, shorten hospital stay, and improve outcomes following elective general surgery [25].

Limitations

This study has several limitations. It was conducted at a single tertiary-care hospital with a relatively small sample size, which may limit the generalizability of the findings. Although the sample-size calculation based on the prespecified prevalence and margin of error indicated a larger minimum sample, only 100 consecutive eligible patients were available during the predefined six-month study period. The relatively small number of patients who developed surgical-site skin complications also limited the number of outcome events available for multivariable analysis. This may have affected the stability and precision of the regression estimates. The follow-up period was restricted to 30 days and may not have captured late postoperative skin complications. Additionally, microbiological confirmation was not available for all suspected infections, and unmeasured confounding factors such as nutritional status, surgeon experience, perioperative antibiotic compliance, and other institutional factors may have influenced the observed outcomes. Finally, the study was observational; therefore, the identified associations should not be interpreted as proof of causality.

Conclusion

Surgical site skin complications remain a common postoperative problem following elective general surgery, affecting approximately one-fifth of patients in this study. Obesity, diabetes mellitus, smoking, prolonged operative duration (>120 minutes), and contaminated wounds were identified as independent risk factors. Early identification of high-risk patients, optimization of modifiable risk factors, and strict adherence to evidence-based perioperative infection prevention protocols may reduce postoperative morbidity, shorten hospital stay, and improve overall surgical outcomes.

Ethical Approval

The Institutional Review Board (IRB) of Lady Reading Hospital Medical Teaching Institution (LRH-MTI), Peshawar, Pakistan, granted ethical approval. The IRB approved Dr. Muhammad Kalim for the study “Frequency and Risk Factors of Surgical Site Skin Complications Following Elective General Surgery: A Prospective Observational Study” (Ref. No. 53-A/LRH/MTI; dated 04/02/2026).

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Authors' Contributions

Authors Contribution

Waleed Mabood: Conceptualization and study design, data acquisition, interpretation of results, manuscript drafting, and final approval of the version to be published.

Sheik Muhammad Ibqar Azeem: Conceptualization and study design, data acquisition, critical revision of the manuscript for important intellectual content, and final approval of the version to be published.

Shoaib Muhammad: Data acquisition, data analysis and interpretation, critical revision of the manuscript, and final approval of the version to be published.

Shahid Ullah Ahmad: Data acquisition, interpretation of results, critical revision of the manuscript for important intellectual content, and final approval of the version to be published.

Sahibzada Salma Rahman: Data collection, literature review, interpretation of results, critical revision of the manuscript, and final approval of the version to be published.

Muhammad Kalim: Conceptualization and supervision of the study, data analysis and interpretation, drafting and critical revision of the manuscript, and final approval of the version to be published.

All authors agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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