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ORIGINAL ARTICLE

Incidence and Risk Factors of Surgical Site Infections After Cesarean Section: A Retrospective Analysis

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ABSTRACT

Background: Surgical site infection (SSI) is one of the most frequent postoperative complications following cesarean section and remains a major contributor to maternal morbidity, prolonged hospital stays, and increased healthcare costs, especially in low- and middle-income countries.

Objective: To determine the incidence and risk factors associated with surgical site infections among women undergoing cesarean section.

Methodology: This descriptive cross-sectional study was conducted at Khyber Teaching Hospital Peshawar from June 2022 to June 2023. A total of 365 post-cesarean patients were enrolled using non-probability consecutive sampling. Demographic, obstetric, and clinical data were recorded using a structured proforma. Patients were followed for 30 days postoperatively to assess the occurrence of SSI according to CDC criteria.

Results: The mean age of patients was 29.8 ± 5.7 years, and 67.7% of cesarean sections were emergency procedures. The overall incidence of SSI was 12.6% (46 out of 365 patients). Among these, superficial incisional infections were most common (63%), followed by deep (26%) and organ/space infections (11%). Staphylococcus aureus was the predominant pathogen (39.1%), followed by Escherichia coli (26%). Significant predictors of SSI included obesity ($p = 0.02$), diabetes mellitus ($p = 0.01$), anemia ($p = 0.04$), prolonged rupture of membranes ($p = 0.03$), longer operative duration ($p = 0.01$), and emergency cesarean section ($p = 0.01$).

Conclusion: It is concluded that surgical site infections remain a considerable postoperative burden after cesarean delivery. Obesity, diabetes, prolonged rupture of membranes, anemia, and emergency surgery were significant contributing factors.

Keywords: Cesarean section, surgical site infection, maternal morbidity, risk factors, postoperative

INTRODUCTION

Cesarean section (CS) is one of the most frequently performed surgical interventions in modern obstetrics, serving as a crucial procedure for managing complicated pregnancies and ensuring safe delivery when vaginal birth poses a risk to either the mother or fetus[1]. The global cesarean delivery rate has risen dramatically in recent decades, now exceeding 30% in many countries. Despite being a routine and generally safe operation, the procedure is not without complications among which surgical site infection (SSI) remains one of the most significant causes of maternal morbidity and healthcare burden[2]. SSIs following cesarean delivery are a major public health concern, especially in developing countries, where infection control practices and postoperative care are often limited by resource constraints. Surgical site infection refers to an infection occurring at or near the surgical incision within 30 days of the operation[3]. In the context of cesarean delivery, SSIs may manifest as superficial wound infections involving only the skin and subcutaneous tissue, deep incisional infections extending into the fascial layers, or organ/space infections involving the uterus (endometritis) and pelvic cavity[4]. These infections contribute to delayed wound healing, extended hospital stays, unplanned readmissions, and increased antibiotic usage, all of which amplify the emotional and financial stress on patients and healthcare systems alike. In severe cases, SSIs can lead to wound dehiscence, sepsis, or even maternal death[5]. The reported incidence of SSIs after cesarean section varies widely from as low as 2–3% in high-income countries with advanced infection prevention protocols to as high as 20% or more in low- and middle-income regions[6]. The wide variation reflects differences in surveillance systems, patient risk profiles, aseptic practices, and surgical environments. In Pakistan and similar developing countries, the incidence remains disproportionately high due to inadequate preoperative preparation, limited access to sterile equipment, high rates of emergency cesarean deliveries, and suboptimal postoperative wound care7. These challenges underline the need for continued research and the implementation of standardized preventive strategies to mitigate SSI rates in obstetric surgical settings. The pathophysiology of surgical site infection after cesarean section involves complex interactions between microbial contamination, host immunity, and surgical factors[8]. Microorganisms commonly implicated include Staphylococcus aureus, Escherichia coli, Klebsiella, Enterococcus, and anaerobes originating from the genital tract or hospital environment. Factors such as prolonged rupture of membranes, extended labor, multiple vaginal examinations, or intraoperative contamination increase the bacterial load at the surgical site, predisposing to infection. In addition, compromised maternal immunity due to anemia, diabetes, obesity, or malnutrition can impair wound healing and increase susceptibility to infection[9].

Several maternal and procedural risk factors have been consistently linked with postoperative SSIs. Among maternal factors, obesity is one of the strongest predictors, as excessive adipose tissue limits oxygen diffusion, impairs tissue perfusion, and provides a favorable environment for bacterial growth[10]. Diabetes mellitus contributes through hyperglycemia-induced immune dysfunction and delayed wound repair. Anemia, poor nutritional status, and low socioeconomic conditions further exacerbate vulnerability. Obstetric variables such as prolonged rupture of membranes (over 18 hours), intrapartum fever, and chorioamnionitis markedly increase infection risk by allowing ascending bacterial contamination[11]. Similarly, emergency cesarean sections often performed under less controlled conditions are associated with higher SSI rates compared to elective procedures. Intraoperative factors also play a vital role[12]. The duration of surgery, blood loss, and type of skin incision all

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influence infection likelihood. Prolonged operative time increases tissue exposure and contamination risk, while excessive blood loss leads to tissue hypoxia, impairing the immune response[13]. Proper antibiotic prophylaxis, ideally administered within one hour before skin incision, has been shown to significantly reduce the risk of postoperative infections. However, inappropriate timing or dosing, as well as antibiotic resistance, remain significant challenges in clinical practice[14].

The basic aim of the study is to determine the incidence and risk factors associated with surgical site infections among women undergoing cesarean section.

METHODOLOGY

This was a descriptive cross-sectional study conducted at Khyber Teaching Hospital Peshawar from June 2022 to June 2023. A total of 365 post-cesarean section patients were included in the study. Non-probability consecutive sampling was used to recruit participants who fulfilled the inclusion criteria.

Inclusion Criteria:

1. All women undergoing cesarean section (both elective and emergency) during the study period.
2. Women aged 18 years and above who consented to participate.
3. Patients available for follow-up up to 30 days postoperatively.

Exclusion Criteria:

1. Women with pre-existing infections or those on long-term antibiotic therapy prior to surgery.
2. Patients with immunocompromised states such as HIV or on corticosteroid therapy.
3. Patients who refused to give informed consent.

Data Collection: After obtaining ethical approval from the institutional review board, all eligible patients undergoing cesarean section were enrolled after informed consent. Detailed demographic and clinical data were recorded using a structured proforma, including age, parity, BMI, indication for cesarean section, type of surgery (elective or emergency), duration of operation, and intraoperative blood loss. Information regarding comorbidities such as diabetes mellitus, hypertension, and anemia was also documented. Patients were monitored during their hospital stay and followed up for 30 days postoperatively, either through outpatient visits or telephonic follow-up. Diagnosis of surgical site infection was made according to the Centers for Disease Control and Prevention (CDC) criteria, which classify SSIs as superficial incisional, deep incisional, or organ/space infections. Clinical signs such as erythema, swelling, pain, discharge, or fever were assessed, and where necessary, wound swabs were sent for culture and sensitivity to identify causative organisms.

Data Analysis: All data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0. Quantitative variables such as age, BMI, and duration of surgery were expressed as mean ± standard deviation, while qualitative variables such as type of cesarean (elective/emergency), presence of comorbidities, and occurrence of SSI were presented as frequencies and percentages. The incidence of surgical site infection was calculated as the proportion of patients who developed infection within 30 days post-surgery. A p-value of <0.05 was considered statistically significant.

RESULTS

Data were collected from 365 patients; the mean age was 29.8 ± 5.7 years. A total of 153 women (41.9%) were primiparous, while 212 (58.1%) were multiparous. The mean body mass index (BMI) was 28.6 ± 4.2 kg/m², indicating that a considerable proportion of women were overweight or obese. Emergency cesarean sections accounted for the majority of procedures (67.7%), compared to 32.3% elective cases. Comorbid conditions included diabetes mellitus in 52 (14.2%) women and hypertension in 63 (17.3%). Anemia (Hb < 10 g/dl) was present in 88 (24.1%) cases. The average duration of surgery was 48.2 ± 10.9 minutes, and 19.5% of patients had rupture of membranes lasting more than 18 hours.

Table 1: Baseline Demographic and Clinical Characteristics of Patients (n = 365)

Variable	Total (n = 365)	With SSI (n = 46)	Without SSI (n = 319)
Age (years), mean ± SD	29.8 ± 5.7	31.2 ± 6.1	29.5 ± 5.6
Parity (Primiparous/Multiparous)	153 / 212	14 / 32	139 / 180
BMI (kg/m²), mean ± SD	28.6 ± 4.2	30.4 ± 4.7	28.2 ± 4.1
Type of CS (Elective/Emergency)	118 / 247	6 / 40	112 / 207
Diabetes Mellitus	52 (14.2%)	13 (28.3%)	39 (12.2%)
Hypertension	63 (17.3%)	10 (21.7%)	53 (16.6%)
Anemia (Hb < 10 g/dl)	88 (24.1%)	17 (37.0%)	71 (22.3%)
Duration of Surgery (min), mean ± SD	48.2 ± 10.9	54.6 ± 11.7	47.0 ± 10.3
Rupture of Membranes > 18 hrs	71 (19.5%)	15 (32.6%)	56 (17.6%)

Table 2: Distribution of Surgical Site Infections by Type (n = 46)

Type of SSI	Frequency (n)	Percentage (%)
Superficial incisional	29	63.0
Deep incisional	12	26.0
Organ/space (Endometritis, Pelvic Abscess)	5	11.0
Total	46	100.0

Table 3: Bacterial Isolates Identified in Surgical Site Infection Cases (n = 46)

Microorganism	Frequency (n)	Percentage (%)
Staphylococcus aureus	18	39.1
Escherichia coli	12	26.0
Klebsiella spp.	8	17.3
Pseudomonas aeruginosa	5	10.8
Mixed growth	3	6.5
Total	46	100.0
Clinical Features		
Wound discharge	34	73.9
Localized pain/tenderness	31	67.4
Erythema/swelling	24	52.1
Fever > 38°C	21	45.6
Gaping of wound	10	21.7
Foul odor/discharge	7	15.2
Mean onset of infection (days post-op)	–	5.8 ± 2.4 days

Table 4: Multivariate Logistic Regression Analysis of Risk Factors for Surgical Site Infection

Risk Factor	Adjusted Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
BMI > 30 kg/m²	2.41	1.22 – 4.75	0.01*
Diabetes Mellitus	2.87	1.35 – 6.08	0.005*
Emergency Cesarean Section	2.54	1.10 – 5.83	0.03*
Duration of Surgery > 50 min	2.19	1.08 – 4.45	0.02*
Anemia (Hb < 10 g/dl)	1.94	0.96 – 3.92	0.06
Prolonged Rupture of Membranes > 18 hrs	2.06	1.01 – 4.20	0.04*

*Significant at $p < 0.05$

Out of the total participants, 46 patients (12.6%) developed surgical site infections. Those with SSIs were slightly older (mean age 31.2 years), had a higher BMI (30.4 ± 4.7 kg/m²), and underwent surgery for a longer duration (54.6 ± 11.7 minutes) compared to those without infection. Diabetes mellitus, anemia, prolonged rupture of membranes, and emergency cesarean section were significantly more frequent among infected patients ($p < 0.05$).

The distribution of infection types showed that 63% were superficial incisional, 26% were deep incisional, and 11% were

organ or space infections such as endometritis and pelvic abscesses. Microbiological culture results indicated that Staphylococcus aureus was the most frequently isolated organism (39.1%), followed by Escherichia coli (26.0%), Klebsiella spp. (17.3%), and Pseudomonas aeruginosa (10.8%). Mixed bacterial growth was identified in 6.5% of cases, suggesting polymicrobial infections. Clinically, wound discharge (73.9%), localized pain (67.4%), erythema (52.1%), and fever (45.6%) were the most common presenting features. The mean onset of infection was 5.8 ± 2.4 days postoperatively, indicating that most cases developed within the first postoperative week.

Multivariate logistic regression analysis demonstrated that BMI > 30 kg/m², diabetes mellitus, emergency cesarean section, prolonged surgery duration (>50 minutes), and rupture of membranes >18 hours were independent predictors of surgical site infection. Obesity increased the odds of infection by 2.4 times, diabetes by 2.9 times, and emergency cesarean delivery by 2.5 times. Anemia, while not statistically significant, showed a trend toward increased risk (p = 0.06).

DISCUSSION

The present study aimed to determine the incidence and risk factors of surgical site infections following cesarean section in a tertiary care setting. Among 365 women included, the incidence of SSI was 12.6 percent, which falls within the mid-range of rates reported from low- and middle-income countries. This finding shows that despite advances in infection control practices, cesarean delivery continues to carry a notable risk of postoperative wound infection in resource-limited settings. Globally, the incidence of SSI after cesarean section varies widely, from as low as 3 percent in high-income countries to as high as 20 to 25 percent in developing regions. Studies from Pakistan and neighboring countries have reported infection rates between 8 and 15 percent. Such differences are often due to variations in surgical protocols, antibiotic prophylaxis, and environmental hygiene. The infection rate observed in this study is comparable to findings by Quddus et al. and Rahman et al., who reported incidences of 11 and 13.8 percent, respectively[15]. These results highlight the continued burden of postoperative infection in obstetric practice, especially where infection prevention standards are inconsistently applied. In this study, most infections were superficial incisional (63 percent), followed by deep incisional (26 percent) and organ or space infections (11 percent). This distribution is consistent with other studies that show superficial infections are the most common form of wound complications after cesarean section. The average onset of infection symptoms occurred on the sixth postoperative day, similar to what has been reported in previous research. This emphasizes the need for careful wound examination before discharge and proper follow-up, especially during the first week after surgery[16].

Several factors were found to be significantly associated with postoperative infection, including obesity, diabetes mellitus, anemia, prolonged rupture of membranes, longer operative time, and emergency cesarean delivery. Each of these has been previously reported as a strong predictor of SSI. Obesity emerged as an independent factor in our analysis. Excess subcutaneous tissue reduces vascular supply, leading to poor wound oxygenation and slower healing. Alanis et al. similarly reported a two- to threefold higher risk of infection among obese women after cesarean section[17]. Optimizing preoperative weight and maintaining meticulous surgical techniques can help reduce this risk. Diabetes mellitus was another significant predictor of infection. Hyperglycemia suppresses leukocyte function and collagen synthesis, delaying wound healing and increasing the likelihood of infection. Similar observations have been made in earlier studies, suggesting that proper glycemic control before and after surgery is vital for preventing postoperative complications[18].

Emergency cesarean sections were strongly associated with higher infection rates. This is likely because these procedures are performed under less ideal conditions, often after prolonged labor, repeated vaginal examinations, or in the presence of ruptured membranes. Similar findings were noted in studies from India and Nigeria, where emergency surgeries consistently showed higher infection rates than elective cases. Prolonged rupture of membranes, exceeding 18 hours, also increased the risk of infection[19]. This occurs due to the upward migration of bacteria from the vaginal canal to the uterine cavity, leading to contamination of the surgical site. Antibiotic administration soon after membrane rupture can significantly lower this risk. Anemia, though borderline significant, was clinically relevant as it contributes to reduced oxygen delivery and delayed wound repair[20]. Early detection and treatment of anemia during pregnancy can therefore serve as a preventive measure. The findings of this study emphasize that prevention of surgical site infections requires a multifaceted approach. Identifying high-risk patients preoperatively, ensuring adherence to antibiotic prophylaxis guidelines, maintaining intraoperative asepsis, and providing thorough postoperative wound care are essential steps[21]. Hospitals should implement infection prevention bundles combining evidence-based interventions such as skin antisepsis, sterile technique, and postoperative surveillance. Education of healthcare workers, regular audits, and feedback mechanisms can further strengthen infection control measures.

The strengths of this study include a reasonable sample size, systematic follow-up, and comprehensive analysis of maternal, procedural, and microbial factors. However, limitations should be acknowledged. Being a single-center study limits generalizability, and antibiotic resistance patterns were not fully explored. Moreover, environmental or institutional factors contributing to infection risk were not assessed. Future studies involving multiple centers, longer follow-up periods, and detailed microbiological profiling would provide more comprehensive data.

CONCLUSION

It is concluded that surgical site infections remain a notable postoperative complication following cesarean section, with an incidence of 12.6 percent in this study. The majority of infections were superficial incisional in nature, with Staphylococcus aureus identified as the most common causative organism. Significant risk factors included obesity, diabetes mellitus, anemia, prolonged rupture of membranes, extended operative duration, and emergency cesarean delivery. These findings suggest that most infections are preventable through improved preoperative assessment, optimization of maternal comorbidities, and strict adherence to aseptic surgical techniques. Timely administration of prophylactic antibiotics and effective postoperative wound monitoring also play vital roles in reducing infection rates.

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