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Original Research Article

Risk Factors Associated with Surgical Site Infection Following Caesarean Section: A Prospective Observational Study

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Abstract

Background: Surgical site infection (SSI) following caesarean section is a major postoperative complication contributing to maternal morbidity, prolonged hospital stay, and increased healthcare burden. Identification of modifiable risk factors is essential for developing effective preventive strategies.

Methods: A prospective observational study was conducted among 300 women undergoing caesarean section at a tertiary care hospital. Participants were followed postoperatively for 30 days for detection of SSI according to Centers for Disease Control and Prevention (CDC) criteria. Maternal, obstetric, and perioperative factors were recorded and analysed. Risk factors associated with SSI were evaluated using univariate analysis and multivariate logistic regression.

Results: Among 300 caesarean deliveries, 15 women developed SSI, giving an incidence of 5.0%. Superficial incisional SSI was the most common type (80.0%). Significant risk factors associated with SSI included obesity (40.0% vs 14.7%, p=0.008), anaemia (53.3% vs 18.9%, p=0.002), emergency caesarean section (80.0% vs 44.2%, p=0.009), prolonged rupture of membranes (40.0% vs 12.6%, p=0.004), multiple vaginal examinations (53.3% vs 18.9%, p=0.002), and operative duration >60 minutes (60.0% vs 22.1%, p<0.001). Multivariate analysis identified prolonged operative duration, anaemia, emergency caesarean section, obesity, prolonged rupture of membranes, and multiple vaginal examinations as independent predictors of SSI.

Conclusion: SSI following caesarean section remains a significant maternal health concern. Early risk identification and targeted preventive measures may reduce postoperative infectious complications.

Keywords: Caesarean section; Surgical site infection; Risk factors; Maternal morbidity; Wound infection; Obstetric surgery.

Introduction

Caesarean section (CS) is one of the most commonly performed obstetric surgical procedures worldwide and represents an essential intervention for preventing adverse maternal and neonatal outcomes when vaginal delivery is contraindicated or associated with increased risk. The global prevalence of caesarean delivery has increased substantially over recent decades due to changing obstetric practices, improved fetal monitoring, increasing maternal age, and a rising incidence of high-risk pregnancies [1,2]. Despite advances in surgical techniques, anaesthesia, and perioperative care, caesarean section remains a major abdominal operation associated with several postoperative complications. Among these, surgical site infection (SSI) is one of the most frequent and clinically important causes of maternal morbidity [3].Surgical site infection following caesarean section is defined as an infection occurring at or near the surgical incision within 30 days following the procedure, or within one year when an implant is placed. Based on the Centers for Disease Control and Prevention (CDC) criteria, SSIs are classified into superficial incisional, deep incisional, and organ/space infections depending on the anatomical involvement [3,4]. These infections significantly affect maternal recovery by causing postoperative pain, delayed wound healing, prolonged hospital

stay, increased healthcare expenditure, and psychological distress. In severe cases, SSI may result in wound dehiscence, pelvic abscess formation, septicemia, and increased risk of maternal mortality [4].The incidence of SSI after caesarean section varies widely across different healthcare settings and geographical regions. This variation is influenced by multiple factors, including healthcare infrastructure, socioeconomic conditions, infection prevention practices, antibiotic prophylaxis protocols, surgical expertise, and patient-related risk factors [5]. While developed countries report relatively lower SSI rates due to established surveillance systems and standardized infection control measures, higher incidences are observed in low- and middle-income countries (LMICs) because of limited resources, inadequate infection monitoring, delayed presentation, and a higher prevalence of maternal risk factors [5,6]. In India, with the increasing number of caesarean deliveries, postoperative wound infection remains a significant clinical concern, particularly in tertiary care centres managing emergency procedures and high-risk obstetric cases [7].The occurrence of SSI following caesarean section is multifactorial and results from the complex interaction of maternal, obstetric, surgical, and environmental factors. Maternal conditions such as obesity, diabetes mellitus, anaemia, malnutrition, hypertensive disorders of pregnancy, and impaired immunity can negatively influence tissue repair and increase susceptibility to infection. Obstetric factors including prolonged labour, premature rupture of membranes, multiple vaginal examinations, chorioamnionitis, and emergency caesarean delivery contribute to increased bacterial exposure and higher infection risk [6,8]. Emergency caesarean sections are particularly associated with greater SSI incidence due to inadequate preoperative optimization, active labour, and limited opportunity for preventive interventions [8].Surgical and perioperative factors also play a crucial role in SSI development. Prolonged operative duration, excessive intraoperative blood loss, inadequate skin preparation, delayed or inappropriate administration of prophylactic antibiotics, poor surgical technique, and failure to maintain strict aseptic precautions may increase the likelihood of postoperative infection [4,9]. Although appropriate antibiotic prophylaxis has significantly reduced SSI rates following caesarean delivery, infections continue to occur, especially among women with prolonged rupture of membranes, pre-existing infections, or other high-risk conditions [10]. Furthermore, irrational and excessive antibiotic use has contributed to the emergence of antimicrobial-resistant organisms, creating additional challenges in the management of postoperative infections [11].The microbial profile of caesarean section-related SSI commonly includes both gram-positive and gram-negative organisms. Frequently isolated pathogens include Staphylococcus aureus, coagulase-negative staphylococci, Escherichia coli, Klebsiella species, and other enteric organisms. The majority of pathogens responsible for SSIs originate from the patient's endogenous flora, although healthcare-associated transmission may also contribute [12]. Increasing antimicrobial resistance among these pathogens has become a major concern, emphasizing the need for continuous surveillance, rational antibiotic use, and identification of modifiable risk factors. Prevention of SSI following caesarean section requires a comprehensive approach involving appropriate patient risk assessment, optimization of maternal health conditions, timely antibiotic prophylaxis, adherence to surgical safety protocols, maintenance of operating room sterility, and early identification of wound complications [1,4]. Prospective evaluation of risk factors can help identify women at increased risk, improve perioperative planning, and guide targeted preventive strategies. Despite improvements in obstetric care, SSI following caesarean section continues to contribute substantially to maternal morbidity, particularly in resource-limited settings. Therefore, the present prospective observational study was conducted to determine the incidence and identify the risk factors associated with surgical site infection following caesarean section. Understanding these factors may assist in developing effective preventive measures, improving postoperative outcomes, and enhancing the overall quality of maternal healthcare.

Materials and Methods

Study Design and Study Setting: The present study was conducted as a prospective observational study to evaluate the incidence and identify the risk factors associated with surgical site infection (SSI) following caesarean section. The study was carried out in the Department of Obstetrics and Gynaecology at a tertiary care hospital. The study was conducted at ESIC Medical College and Post Graduate Institute of Medical Sciences and Research (PGIMSR), Kalaburagi, Karnataka, India, over a period of seven months

Study Population: The study included women undergoing caesarean section during the study period. All participants were monitored prospectively for the development of surgical site infection following caesarean delivery. Baseline demographic characteristics, obstetric details, perioperative variables, and postoperative outcomes were recorded and analysed to identify factors associated with SSI.

Inclusion Criteria: Women were included in the study if they fulfilled the following criteria:

- Women undergoing caesarean section during the study period.
- Age ≥18 years.
- Patients willing to participate and provide informed consent.
- Patients available for postoperative follow-up for assessment of wound-related complications.

Exclusion Criteria: Patients were excluded from the study if they had:

- Pre-existing infection at the surgical site before caesarean section.
- Known immunodeficiency disorders.
- Current systemic infection unrelated to caesarean delivery.
- Patients unwilling to participate or lost to follow-up.
- Caesarean delivery performed outside the study hospital.

Data Collection and Study Procedure: After obtaining informed consent, detailed demographic, clinical, obstetric, and perioperative information was collected using a predesigned structured proforma.

The following parameters were recorded:

Maternal Characteristics

- Age
- Body mass index (BMI)
- Parity
- Nutritional status
- Presence of anaemia
- Diabetes mellitus
- Hypertensive disorders of pregnancy
- Other associated medical conditions

Obstetric Characteristics

- Indication for caesarean section
- Elective or emergency caesarean delivery
- Gestational age at delivery
- Duration of labour
- Duration of rupture of membranes
- Number of vaginal examinations before surgery
- Presence of chorioamnionitis or intra-amniotic infection
- Previous caesarean section

Perioperative and Surgical Variables: The following surgical details were documented:

- Type of caesarean section
- Duration of surgery
- Estimated intraoperative blood loss
- Type of anaesthesia used
- Timing and type of prophylactic antibiotic administration
- Intraoperative complications
- Surgical wound characteristics

Assessment of Surgical Site Infection: All patients were followed prospectively after caesarean delivery for detection of SSI. Surgical site infection was diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria.

SSI was classified as:

Superficial Incisional SSI: Infection involving only the skin and subcutaneous tissue of the incision, presenting with features such as:

- Purulent discharge from incision
- Localized pain, swelling, redness, or warmth
- Wound dehiscence with evidence of infection

Deep Incisional SSI: Infection involving deeper soft tissues such as fascia and muscle, identified by:

- Purulent discharge from deeper incision
- Spontaneous wound separation
- Abscess formation or evidence of deep infection

Organ/Space SSI: Infection involving pelvic organs or spaces, diagnosed clinically or radiologically.

Patients developing SSI were evaluated for clinical presentation, time of onset, severity, treatment received, microbiological findings, and clinical outcome.

Microbiological Evaluation: In patients with suspected SSI, wound specimens were collected under aseptic precautions and sent for microbiological analysis. Samples were processed for bacterial identification and antimicrobial susceptibility testing according to standard laboratory protocols. The isolated organisms and their antibiotic sensitivity patterns were documented.

Postoperative Follow-up: All participants were followed during hospitalization and after discharge up to 30 days following caesarean section for identification of SSI. Follow-up assessments included:

- Wound inspection
- Presence of fever or systemic signs of infection
- Wound discharge
- Need for antibiotic therapy
- Wound management procedures
- Readmission due to infection
- Maternal outcome

Outcome Measures

Primary Outcome

- Development of surgical site infection within 30 days following caesarean section.

Secondary Outcomes

- Identification of risk factors associated with SSI.
- Microbiological profile of infected wounds.
- Duration of hospital stay.
- Management and clinical outcomes of SSI cases.

Statistical Analysis: The collected data were entered into a computerized database and analysed using SPSS .26. Statistical software. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range, depending on data distribution. Categorical variables were presented as frequencies and percentages. Comparison between patients with and without SSI was performed using the Student's t-test/Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. Variables showing significant association on univariate analysis were entered into multivariate logistic regression analysis to identify independent predictors of SSI. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A p-value <0.05 was considered statistically significant.

Result

A total of 300 women who underwent caesarean section were included in the study. The mean maternal age was 27.8 ± 4.6 years. Most participants were aged 25–34 years (61.3%), followed by <25 years (27.3%) and ≥35 years (11.3%). Primigravidae constituted 56.0% of the study population, while 44.0% were multigravidae. Regarding body mass index, 52.0% had a normal BMI, 32.0% were overweight, and 16.0% were obese. The majority of deliveries occurred at term (92.0%), and 32.0% of women had a previous caesarean section (Table 1).

The overall incidence of surgical site infection (SSI) following caesarean section was 5.0% (15/300), while 95.0% of women had no evidence of SSI. Most infections were detected within the first 7 postoperative days (66.7%), followed by 8–14 days (26.7%) and 15–30 days (6.6%). Superficial incisional SSI was the predominant type (80.0%), whereas deep incisional and organ/space infections accounted for 13.3% and 6.7%, respectively. Wound discharge (86.7%) was the most common clinical presentation, followed by fever (46.7%), wound dehiscence (20.0%), and readmission (13.3%) (Table 2).Comparison of maternal characteristics demonstrated that maternal age ≥35 years (26.7% vs. 10.5%, p=0.047), obesity (40.0% vs. 14.7%, p=0.008), anaemia (53.3% vs. 18.9%, p=0.002), and diabetes mellitus (20.0% vs. 5.3%, p=0.028) were significantly more common among women who developed SSI. In contrast, hypertensive disorders of pregnancy, previous caesarean section, and malnutrition were not significantly associated with SSI (Table 3, Figure 1).

Assessment of obstetric and perioperative factors revealed that emergency caesarean section (80.0% vs. 44.2%, p=0.009), prolonged labour >12 hours (46.7% vs. 14.7%, p=0.001), rupture of membranes >24 hours (40.0% vs. 12.6%, p=0.004), multiple vaginal examinations (53.3% vs. 18.9%, p=0.002), operative duration >60 minutes (60.0% vs. 22.1%, p<0.001), intraoperative blood loss >1000 ml (26.7% vs. 8.4%, p=0.028), and delayed antibiotic prophylaxis (20.0% vs. 4.2%, p=0.012) were all significantly associated with postoperative SSI (Table 4). Microbiological analysis of SSI cases showed that Staphylococcus aureus was the most frequently isolated organism (33.3%), followed by Escherichia coli (26.7%), Klebsiella pneumoniae (20.0%), and coagulase-negative Staphylococcus (13.3%). Mixed bacterial growth was observed in 6.7% of cases. Overall, Gram-negative organisms (53.3%) were slightly more prevalent than Gram-positive organisms (46.7%) (Table 5, Figure 2).

On multivariate logistic regression analysis, operative duration >60 minutes (AOR=4.12, 95% CI: 1.44–11.78, p=0.008), anaemia (AOR=3.76, 95% CI: 1.32–10.71, p=0.013), emergency caesarean section (AOR=3.58, 95% CI: 1.21–10.56, p=0.021), obesity (AOR=3.42, 95% CI: 1.18–9.94, p=0.023), prolonged rupture of membranes >24 hours (AOR=3.21, 95% CI: 1.08–9.52, p=0.036), and multiple vaginal examinations (AOR=2.94, 95% CI: 1.02–8.46, p=0.046) emerged as independent predictors of surgical site infection following caesarean section (Table 6, Figure 3).

Table 1: Baseline Demographic and Obstetric Characteristics of Study Participants (n=300)

Variable	Category	Total Study Population (n=300)
Maternal age (years), Mean ± SD		27.8 ± 4.6
Age group	<25 years	82 (27.3%)
	25–34 years	184 (61.3%)
	≥35 years	34 (11.3%)
Parity	Primigravida	168 (56.0%)
	Multigravida	132 (44.0%)
BMI (kg/m²)	Normal (<25)	156 (52.0%)
	Overweight (25–29.9)	96 (32.0%)
	Obese (≥30)	48 (16.0%)

Gestational age at delivery	Term (≥37 weeks)	276 (92.0%)
	Preterm (<37 weeks)	24 (8.0%)
Previous caesarean section	Present	96 (32.0%)
	Absent	204 (68.0%)

Table 2: Incidence and Clinical Characteristics of Surgical Site Infection Following Caesarean Section (n=300)

Parameter	n (%)
Total caesarean deliveries studied	300 (100.0%)
Patients developing SSI	15 (5.0%)
Patients without SSI	285 (95.0%)
Time of SSI detection	
Within 7 days	10 (66.7%)
8–14 days	4 (26.7%)
15–30 days	1 (6.6%)
Type of SSI	
Superficial incisional SSI	12 (80.0%)
Deep incisional SSI	2 (13.3%)
Organ/space SSI	1 (6.7%)
Wound discharge	13 (86.7%)
Fever	7 (46.7%)
Wound dehiscence	3 (20.0%)
Readmission due to SSI	2 (13.3%)

Table 3: Comparison of Maternal Risk Factors between SSI and Non-SSI Groups

Risk Factor	SSI Group (n=15)	Non-SSI Group (n=285)	P value
Maternal age ≥35 years	4 (26.7%)	30 (10.5%)	0.047
BMI ≥30 kg/m²	6 (40.0%)	42 (14.7%)	0.008
Anaemia	8 (53.3%)	54 (18.9%)	0.002
Diabetes mellitus	3 (20.0%)	15 (5.3%)	0.028
Hypertensive disorder of pregnancy	4 (26.7%)	38 (13.3%)	0.142
Previous caesarean section	7 (46.7%)	89 (31.2%)	0.214
Malnutrition	3 (20.0%)	21 (7.4%)	0.093

Statistical test: Chi-square/Fisher's exact test

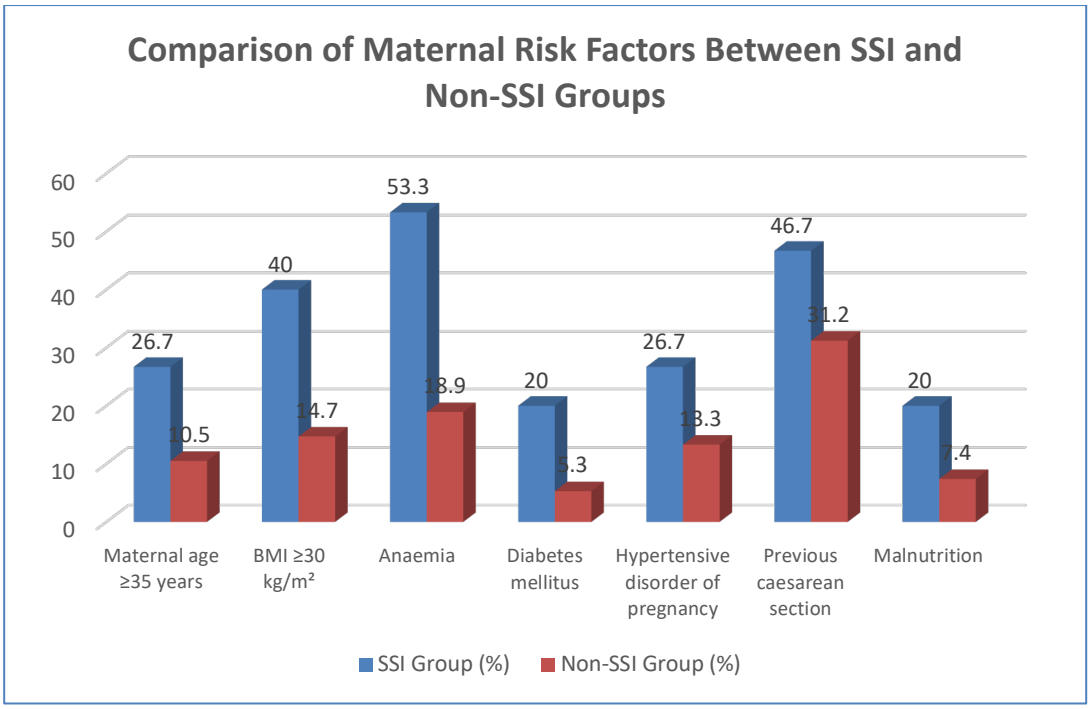

Figure 1: Comparison of Maternal Risk Factors between SSI and Non-SSI Groups

Table 4: Obstetric and Perioperative Risk Factors Associated with SSI

Risk Factor	SSI Group (n=15)	Non-SSI Group (n=285)	P value
Emergency caesarean section	12 (80.0%)	126 (44.2%)	0.009
Prolonged labour (>12 hours)	7 (46.7%)	42 (14.7%)	0.001
Rupture of membranes >24 hours	6 (40.0%)	36 (12.6%)	0.004
Multiple vaginal examinations (>3)	8 (53.3%)	54 (18.9%)	0.002
Duration of surgery >60 minutes	9 (60.0%)	63 (22.1%)	<0.001
Intraoperative blood loss >1000 ml	4 (26.7%)	24 (8.4%)	0.028
Delayed antibiotic prophylaxis	3 (20.0%)	12 (4.2%)	0.012

Table 5: Microbiological Profile of Surgical Site Infection Cases (n=15)

Organism Isolated	n (%)
Staphylococcus aureus	5 (33.3%)
Escherichia coli	4 (26.7%)
Klebsiella pneumoniae	3 (20.0%)
Coagulase-negative Staphylococcus	2 (13.3%)
Mixed bacterial growth	1 (6.7%)
Gram-positive organisms	7 (46.7%)
Gram-negative organisms	8 (53.3%)

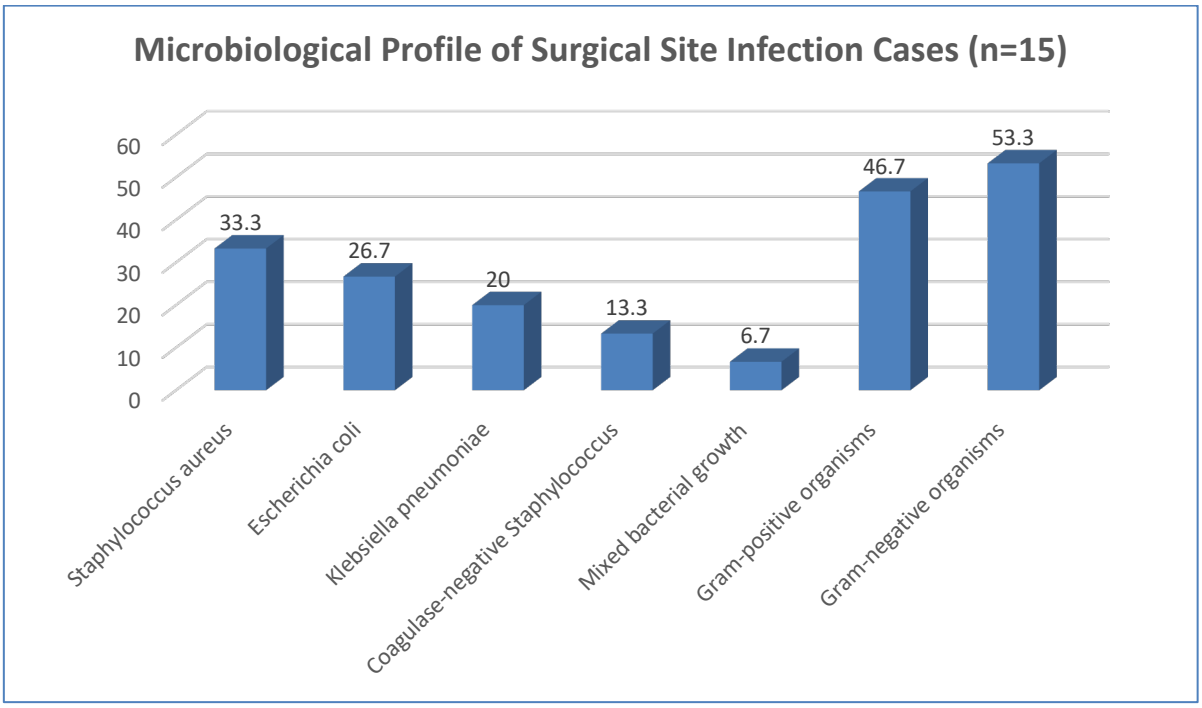

Figure 2: Microbiological Profile of Surgical Site Infection Cases (n=15)

Table 6: Multivariate Logistic Regression Analysis of Independent Predictors of SSI Following Caesarean Section

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	P value
Obesity (BMI ≥30 kg/m²)	3.42	1.18–9.94	0.023
Anaemia	3.76	1.32–10.71	0.013
Emergency caesarean section	3.58	1.21–10.56	0.021
Prolonged rupture of membranes >24 hours	3.21	1.08–9.52	0.036
Multiple vaginal examinations	2.94	1.02–8.46	0.046
Operative duration >60 minutes	4.12	1.44–11.78	0.008

Statistical test: Multivariate logistic regression analysis

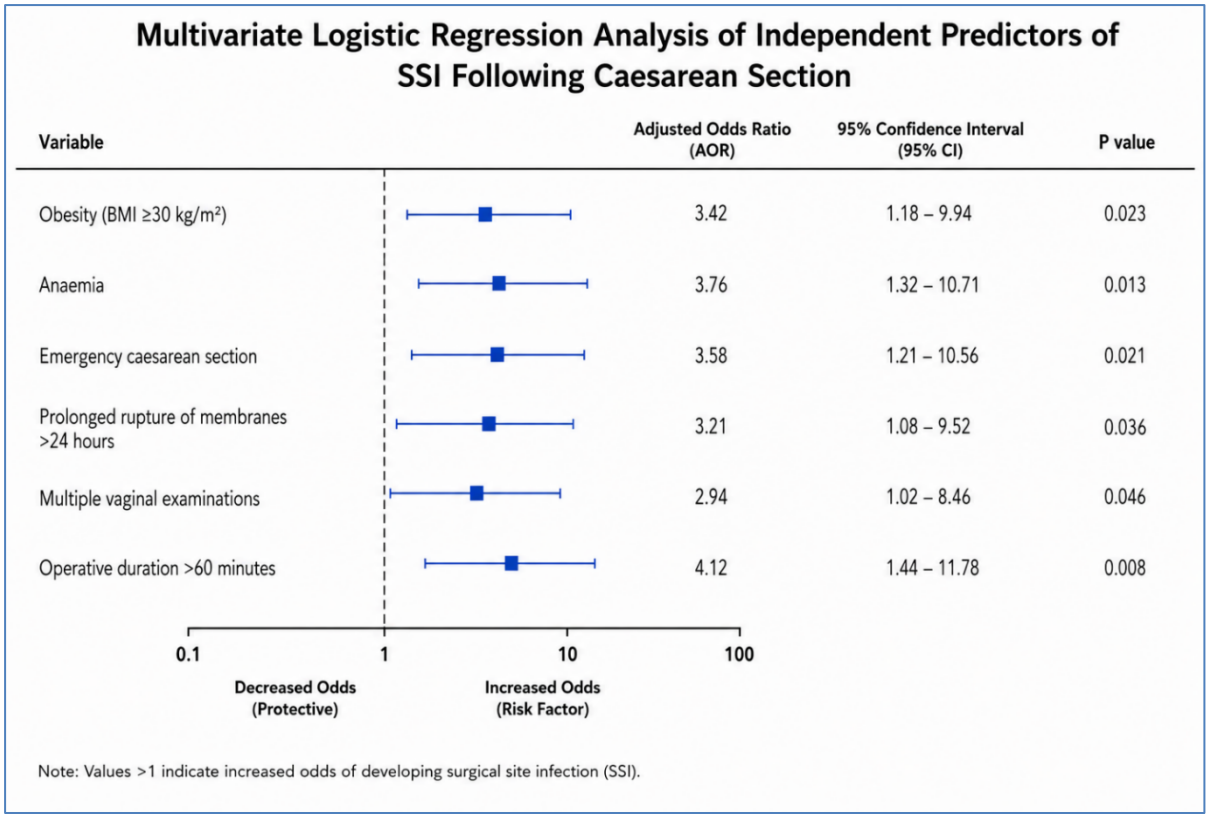

Figure 3: Multivariate Logistic Regression Analysis of Independent Predictors of SSI Following Caesarean Section

Discussion

The present prospective observational study evaluated the incidence, clinical characteristics, and risk factors associated with surgical site infection (SSI) following caesarean section among 300 women. Overall, 15 women developed SSI, resulting in an incidence of 5.0%. Most infections occurred within the first postoperative week, with superficial incisional SSI being the predominant type. Maternal obesity, anaemia, emergency caesarean section, prolonged rupture of membranes, multiple vaginal examinations, and prolonged operative duration were identified as independent predictors of SSI.

The observed SSI incidence of 5.0% is comparable with findings from recent literature. Systematic reviews have reported pooled SSI rates ranging from approximately 3–7% after caesarean delivery, with higher rates in low- and middle-income countries due to variations in surveillance systems, healthcare resources, and patient characteristics. Adane et al.[13] reported a higher SSI incidence of 7.74%, while Shacho et al.[14] also demonstrated a substantial burden of post-caesarean SSI and identified BMI, prolonged labour, operative duration, and treatment timing as important risk factors. The relatively lower incidence in the present study may reflect standardized antibiotic prophylaxis, strict aseptic practices, and effective postoperative surveillance. The mean maternal age was 27.8 ± 4.6 years, with most women (61.3%) aged 25–34 years. Advanced maternal age (≥35 years) was significantly more common among women with SSI (26.7% vs. 10.5%; p=0.047). Similar findings have been reported by Habimana et al.[15], suggesting that increasing maternal age contributes to impaired wound healing and greater susceptibility to postoperative infection. Previous caesarean section was not independently associated with SSI, consistent with earlier studies after adjustment for other maternal and operative factors.

Obesity emerged as an important independent predictor of SSI. Women with BMI ≥30 kg/m² had significantly higher infection rates (40.0% vs. 14.7%; p=0.008), and obesity remained significant on multivariate analysis (AOR 3.42; 95% CI: 1.18–9.94; p=0.023). These findings agree with Shacho et al.[14], who identified obesity as a major contributor to SSI because of impaired tissue perfusion, delayed wound healing, and prolonged operative duration.

Anaemia was another significant risk factor, affecting 53.3% of women with SSI compared with 18.9% without SSI (p=0.002). Multivariate analysis confirmed anaemia as an independent predictor (AOR 3.76; 95% CI: 1.32–10.71; p=0.013). Recent prospective studies have similarly demonstrated that maternal anaemia increases postoperative infection risk by impairing tissue oxygenation and immune function.

Emergency caesarean section was performed in 80.0% of women with SSI compared with 44.2% without SSI (p=0.009), increasing infection risk more than three-fold (AOR 3.58; 95% CI: 1.21–10.56; p=0.021). Emergency procedures are frequently associated with prolonged labour, rupture of membranes, repeated vaginal examinations, and limited preoperative optimization, all of which contribute to increased bacterial contamination.

Prolonged labour (>12 hours), rupture of membranes >24 hours, and more than three vaginal examinations were also significantly associated with SSI. Multiple vaginal examinations remained an independent predictor (AOR 2.94; 95% CI: 1.02–8.46; p=0.046), consistent with previous systematic reviews identifying ascending bacterial contamination as a major mechanism for post-caesarean wound infection. Similarly, operative duration >60 minutes was the strongest operative predictor (AOR 4.12; 95% CI: 1.44–11.78; p=0.008), supporting the findings of Shacho et al.[14]. Among culture-positive cases, Staphylococcus aureus (33.3%), Escherichia coli (26.7%), and Klebsiella pneumoniae (20.0%) were the predominant pathogens, reflecting the combined role of skin flora and enteric organisms in post-caesarean SSI. These findings emphasize the importance of culture-guided antimicrobial therapy and antimicrobial stewardship.

Overall, the present study demonstrates that SSI remains an important cause of maternal morbidity following caesarean section. Early identification of high-risk women, correction of anaemia, optimization of obesity, timely obstetric management, strict antibiotic prophylaxis, and adherence to perioperative infection prevention measures are essential strategies for reducing the burden of SSI after caesarean delivery.

Conclusion

The present study demonstrated that surgical site infection following caesarean section remains an important cause of maternal morbidity, with an overall incidence of 5.0%. Maternal obesity, anaemia, emergency caesarean delivery, prolonged rupture of membranes, multiple vaginal examinations, and prolonged operative duration were identified as significant independent predictors of SSI. Early identification of high-risk patients, optimization of maternal health conditions, and strict adherence to perioperative infection prevention protocols may help reduce SSI occurrence. Implementation of targeted preventive strategies and continuous surveillance can improve postoperative outcomes following caesarean section.

Limitations

The study was conducted at a single tertiary care centre with a relatively limited sample size, which may restrict the generalizability of the findings to other healthcare settings. The follow-up period was limited to 30 days after caesarean section, and late-presenting infections may have been missed. Additionally, some potential risk factors, including socioeconomic status, nutritional parameters, and long-term wound outcomes, were not evaluated. Further multicentric studies with larger sample sizes are required to validate these findings.

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