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Original Research Article

A retrospective study of surgical site infections post caesarean section in a secondary care hospital

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ABSTRACT

Background: Surgical site infection (SSI) is an important healthcare-associated complication following caesarean section and may result in maternal morbidity, prolonged hospital stay, increased healthcare expenditure, and delayed wound healing. Identification of associated risk factors and strengthening preventive practices are essential, particularly in secondary-care settings. Aim was to determine the frequency, pattern, and associated patient-related risk factors of SSI following caesarean section and to identify measures that may contribute to improved infection prevention and postoperative care.

Methods: A retrospective study was conducted at a secondary-care health facility from April 2020 to March 2024. Hospital records of women who underwent caesarean section and subsequently developed SSI were reviewed. Available demographic, obstetric, surgical, and postoperative data, including wound-related complications and management up to 6 weeks after surgery, were analysed.

Results: During the four-year study period, 4,948 caesarean sections were performed, of which 519 (10.4%) were complicated by SSI. Among women with SSI, 122 (23.5%) had superficial wound infections, while 397 (76.4%) developed severe wound gaping requiring re-suturing. The most frequently identified risk factors were obesity (28%), anaemia (24%), and a history of previous surgery (22%), followed by personal hygiene-related factors (14%) and other or unspecified factors (12%). The annual number of caesarean sections increased progressively from 935 to 1,426, whereas the SSI rate declined from 8.1% in 2020-2021 to 6.8% in 2023-2024.

Conclusions: SSI remains a significant postoperative complication following caesarean section, with obesity, anaemia, and previous surgery being prominent associated factors. The decline in SSI rates despite increasing caesarean volumes underscores the potential value of strengthened infection-prevention practices and postoperative surveillance. Early identification of high-risk women, adherence to aseptic surgical practices, appropriate perioperative care, and timely management of wound complications may reduce SSI-related morbidity and improve the quality of obstetric surgical care.

Keywords: Surgical site infection; Caesarean section, Obstetric surgery, Secondary-care hospital, Wound infection

INTRODUCTION

Caesarean section (CS) is one of the most commonly performed obstetric surgical procedures worldwide. Surgical site infection (SSI) is an important postoperative

complication following CS and may result in wound morbidity, prolonged hospital stay, increased healthcare costs, and delayed recovery.^{1,2} The incidence of SSI varies considerably across healthcare settings and geographical

regions, with higher rates reported in low- and middle-income countries.^{3,4}

Several maternal and perioperative factors have been associated with SSI following CS, including obesity, anaemia, prolonged operative duration, excessive blood loss, repeated vaginal examinations, emergency surgery, and inadequate perioperative infection-prevention practices.^{5,6} Appropriate antibiotic prophylaxis, skin preparation, aseptic surgical technique, and postoperative wound surveillance are therefore essential components of SSI prevention.^{7,8}

SSI may range from superficial wound infection to wound disruption requiring prolonged wound care, antibiotics, resuturing, or other interventions. Beyond physical morbidity, these complications can increase patient discomfort, delay recovery, and add to the burden on healthcare resources. Early recognition and appropriate postoperative wound assessment are therefore important for reducing complications and facilitating timely management.

Despite advances in perioperative care, SSI remains a significant concern in resource-constrained and secondary-care settings. Data on the frequency, clinical pattern, and associated risk factors of SSI in such settings are limited.

The present study was undertaken in a secondary-care hospital to determine the frequency and pattern of SSI following caesarean section, identify the commonly documented patient-related risk factors, and assess the temporal trend of SSI over a four-year period. The findings were intended to provide locally relevant evidence to strengthen perioperative infection-prevention practices and postoperative wound surveillance in women undergoing caesarean delivery.

METHODS

Study design and setting

This was a retrospective observational study conducted in the department of obstetrics and gynecology at a secondary-care hospital in Bareilly. The study was undertaken after obtaining institutional ethical clearance. Hospital records of women who underwent cesarean section during the study period from April 2020 to March 2024 were reviewed retrospectively to determine the incidence, clinical characteristics, types, and patient-related risk factors associated with postoperative surgical site infection (SSI).

Study population

The study population comprised pregnant women who underwent caesarean section at the study centre during the defined study period. All available hospital records of women who developed an SSI following caesarean

delivery were reviewed for analysis. The total number of caesarean sections performed during the study period was also recorded to determine the overall incidence of SSI following caesarean section.

Inclusion criteria

Women were included in the analysis if they: had undergone caesarean section at the study hospital during the study period (April 2020 to March 2024); had a documented diagnosis of postoperative surgical site infection following caesarean delivery; and had sufficient clinical and postoperative records available for assessment of the variables included in the study.

Exclusion criteria

Patients were excluded when the medical record was insufficient to establish the presence or characteristics of SSI, or when the postoperative infection was unrelated to the caesarean surgical wound.

Data collection

Relevant information was retrieved from hospital records and entered into a structured data collection format. The variables assessed included demographic characteristics, obstetric characteristics, relevant medical and surgical history, operative details, postoperative wound findings, treatment received, and postoperative outcomes.

The demographic and clinical variables included maternal age, parity, body mass index/obesity status, anaemia, previous surgical history, and other documented maternal comorbidities. Obstetric variables included indication for caesarean delivery and relevant antenatal risk factors where available.

Operative and postoperative variables included the type of caesarean section, postoperative wound status, development of wound infection, wound separation/gaping, requirement for wound resuturing, and other documented postoperative complications. Information regarding the postoperative course was assessed for up to 6 weeks following caesarean delivery, based on available hospital records and follow-up documentation. The original study specifically assessed baseline demographic, obstetric and surgical details together with postoperative complications up to 6 weeks.

Operational definitions

Surgical site infection

Surgical site infection was defined as infection occurring at or involving the surgical site following caesarean delivery and identified clinically during the postoperative period. SSI was classified according to the anatomical depth of involvement into:

Superficial incisional SSI

Infection involving the skin and subcutaneous tissue of the incision.

Deep incisional SSI

Infection involving the deeper soft tissues of the surgical incision.

Organ/space SSI

Infection involving an anatomical structure or space other than the layers of the abdominal wall that had been opened or manipulated during the operative procedure.

This classification is consistent with the conventional CDC classification of surgical site infections.

For the purpose of the present analysis, clinically documented wound gaping/separation requiring secondary intervention, including resuturing, was recorded separately as a postoperative wound complication.

Assessment of potential risk factors

The available records were reviewed for documented patient-related factors potentially associated with postoperative SSI. These included obesity, anaemia, previous surgical history, personal hygiene-related factors, and other documented risk factors. In the study population, obesity, anaemia, and previous surgery constituted the major recorded risk-factor categories.

Where more than one risk factor was documented in an individual patient, each relevant factor was recorded. The analysis therefore describes the distribution of documented risk factors among women who developed SSI rather than assuming that each risk factor was mutually exclusive.

Outcome measures

The primary outcome was the occurrence of SSI following caesarean section, expressed as the proportion of caesarean deliveries complicated by SSI during the study period.

The secondary outcomes included: distribution of SSI according to type/depth of wound involvement; frequency of wound gaping requiring resuturing; distribution of documented patient-related risk factors; annual variation in the number and proportion of caesarean sections complicated by SSI; and postoperative complications documented during follow-up for up to 6 weeks.

Annual assessment

To assess temporal trends, caesarean deliveries and SSI cases were analysed separately for each 12-month interval: April 2020-March 2021, April 2021-March 2022, April 2022-March 2023, April 2023-March 2024.

The annual SSI rate was calculated as:

Annual SSI rate (%) = Number of SSI cases / Total number of caesarean sections × 100

The study recorded 935, 1,283, 1,304 and 1,426 caesarean sections during the four successive study years, with corresponding SSI rates of 8.1%, 9.4%, 7.8% and 6.8%, respectively.

Statistical analysis

Data were compiled and analysed using appropriate descriptive statistical methods. Continuous variables, where available, were summarized using mean and standard deviation or median and interquartile range, depending on the distribution of the data. Categorical variables were expressed as frequencies and percentages.

The overall incidence of SSI was calculated using the total number of caesarean sections performed during the study period as the denominator. The distribution of different SSI types, postoperative wound complications, and documented risk factors was expressed as proportions.

Annual SSI rates were calculated separately for each study year to assess temporal variation. Where appropriate, categorical variables may be compared using the chi-square test or Fisher's exact test, with a two-sided p value of <0.05 considered statistically significant.

Because this was a retrospective record-based study, the analysis was dependent on the completeness and accuracy of information documented in the hospital records. Missing variables were not imputed and were analysed based on available documentation.

RESULTS

During the four-year study period from April 2020 to March 2024, a total of 4,948 caesarean sections were performed. Among these, 519 women developed surgical site infection (SSI), corresponding to an overall SSI rate of 10.4% (Figure 1). Thus, the majority of women undergoing caesarean section did not develop SSI; however, SSI remained a clinically important postoperative complication in the study population.

Among the 4,948 caesarean sections performed during the study period, 519 women developed surgical site infection (SSI). Of these, 122 women (23.5%) had superficial wound infections, whereas 397 women (76.4%) developed significant wound gaping requiring re-suturing (Figure 2). Thus, wound gaping requiring re-suturing constituted the predominant wound complication among women who developed SSI. The findings indicate that, although superficial wound infection accounted for nearly one-fourth of SSI cases, a substantial proportion of affected women developed more extensive wound disruption requiring additional wound management and re-suturing.

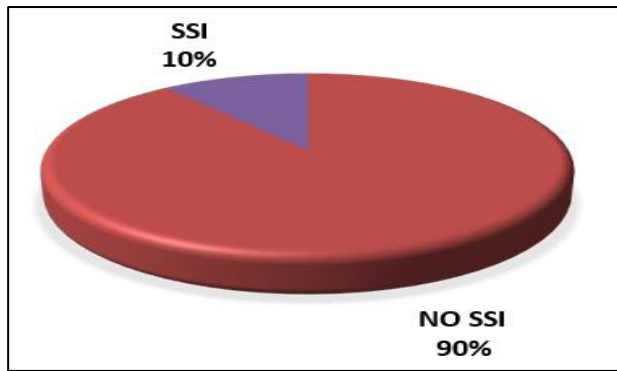


Figure 1: SSI post LSCS.

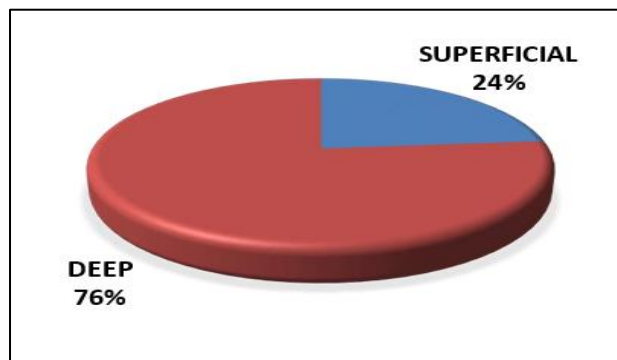


Figure 2: Types of SSI.

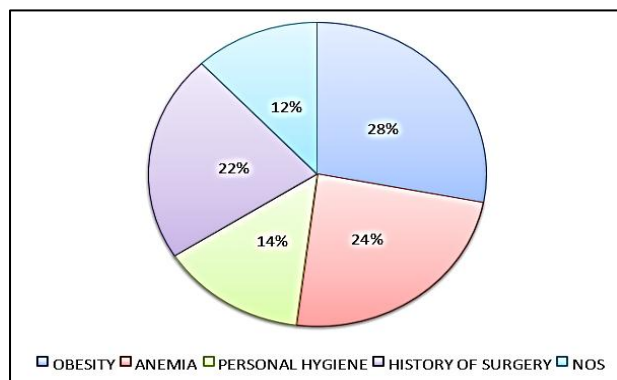


Figure 3: Distribution of documented factors associated with surgical site infection following cesarean section

The distribution of the documented risk factors among women who developed SSI is presented in Figure 3. Obesity was the most frequently reported factor, accounting for 28% of the cases, followed by anaemia (24%) and a history of previous surgery (22%). Personal hygiene-related factors were documented in 14% of cases, while other or not otherwise specified (NOS) factors accounted for the remaining 12%. Collectively, obesity, anaemia, and a history of previous surgery constituted 74% of the documented risk-factor distribution, representing the predominant factors identified among women with SSI in the study population.

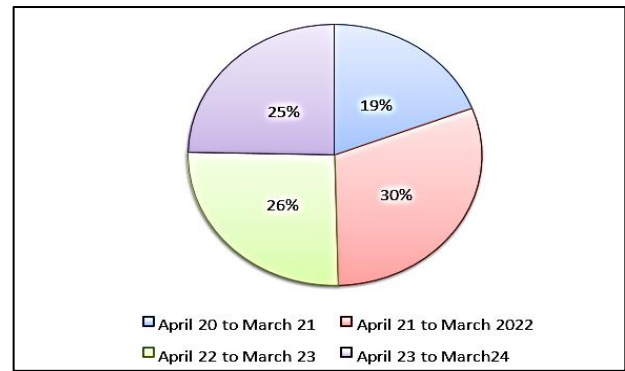


Figure 4: Annual distribution of SSIs requiring re-suturing.

The annual distribution of SSIs requiring re-suturing is shown in Figure 4. During the initial study period (April 2020-March 2021), these cases accounted for 19% of the total. The proportion increased to 30% during April 2021-March 2022. This was followed by a decline, with SSIs requiring re-suturing accounting for 26% and 25% during April 2022-March 2023 and April 2023-March 2024, respectively. Thus, after a peak in the second study year, the distribution remained relatively stable during the subsequent two years.

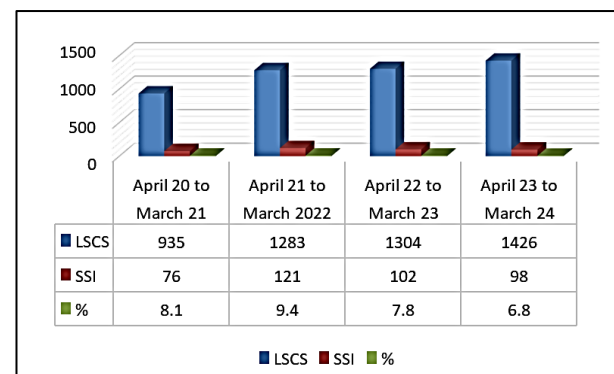


Figure 5: Year-wise distribution of caesarean sections (LSCS) and surgical site infection (SSI) cases from April 2020 to March 2024

Figure 5 illustrates the annual distribution of caesarean sections (LSCS) and surgical site infection (SSI) cases from April 2020 to March 2024. The number of LSCS procedures showed a progressive increase over the four-year study period, from 935 cases in April 2020-March 2021 to 1,283 cases in April 2021-March 2022, 1,304 cases in April 2022-March 2023, and 1,426 cases in April 2023-March 2024.

The annual number of SSI cases increased from 76 in 2020-2021 to 121 in 2021-2022, followed by a decline to 102 in 2022-2023 and 98 in 2023-2024. Overall, although the annual volume of LSCS procedures increased progressively, the number of SSI cases showed a fluctuating pattern, with the highest number recorded during 2021-2022, followed by a decline in subsequent

years. The corresponding SSI rate also decreased over the study period, suggesting an overall improvement in SSI outcomes despite the increasing surgical volume.

DISCUSSION

Surgical site infection (SSI) remains an important postoperative complication following caesarean section and is associated with delayed wound healing, additional treatment, prolonged hospital utilisation, and increased healthcare costs. In the present study, 519 SSI cases were identified among 4,948 caesarean sections performed during the four-year study period, corresponding to an overall SSI rate of approximately 10.4%. This represents a substantial postoperative burden in a secondary-care setting. A recent systematic review and meta-analysis involving 2,188,242 women from 58 countries reported a pooled global post-caesarean SSI incidence of 5.63% (95% CI 5.18-6.11%), with considerably higher rates in low-resource settings. The higher incidence observed in the present study may therefore reflect differences in patient characteristics, healthcare resources, surveillance practices, and institutional infection-prevention practices.¹

The incidence observed in the present study was higher than the 9.13% reported by Harish Babu et al in a rural tertiary-care hospital and substantially higher than the 2.69% reported by Umare et al.^{9,10} Differences between studies may be explained by variations in study populations, definitions of SSI, case-mix, duration of postoperative surveillance, referral patterns, and institutional infection-control practices. Importantly, comparison of SSI rates across hospitals should therefore be interpreted cautiously unless similar case definitions and surveillance methods are used.

In the present study, obesity was the most frequently documented risk factor, accounting for 28% of the identified risk-factor distribution, followed by anaemia (24%) and a history of previous surgery (22%). These findings are consistent with recent evidence demonstrating an association between increased body mass index and postoperative wound infection. A 2024 meta-analysis of obstetric and gynaecological surgical procedures found that increased BMI was significantly associated with SSI, with BMI ≥ 24 kg/m² associated with an approximately 2.7-fold higher odds of infection.³ Similarly, a recent systematic review and meta-analysis specifically evaluating caesarean delivery identified high BMI, previous caesarean section, prolonged membrane rupture, multiple vaginal examinations, diabetes, and hypertensive disorders among important risk factors for post-caesarean SSI.⁴

The relatively high proportion of women with anaemia in the present study is also clinically relevant. Anaemia may adversely affect tissue oxygenation and wound healing and may coexist with nutritional deficiencies and other maternal factors that increase vulnerability to postoperative infection. Recent evidence supports this

association. A 2024 systematic review and meta-analysis reported that women with postoperative hemoglobin levels below 11 gm/dl had a significantly higher risk of SSI following caesarean delivery.⁵ These findings highlight the importance of antenatal screening and treatment of anaemia as part of broader preoperative optimisation, although the retrospective design of the present study does not allow a causal relationship between anemia and SSI to be established.

Previous surgery was documented in 22% of affected women in the present study. Previous caesarean delivery may be associated with a higher risk of postoperative wound complications because of scar tissue, altered tissue planes, adhesions, longer operative procedures, and the increased likelihood of repeated surgical intervention. The recent systematic review of post-caesarean SSI risk factors also identified previous caesarean section as a significant risk factor, with a pooled odds ratio of 1.46.⁴ The present findings therefore reinforce the importance of careful preoperative assessment and appropriate perioperative planning in women undergoing repeat caesarean delivery.

A notable finding in the present study was the predominance of clinically significant wound complications. Of the 519 women identified with SSI, 122 (23.5%) had superficial wound infection, whereas 397 (76.4%) developed substantial wound gaping requiring re-suturing. This finding indicates that SSI in this population was not limited to minor superficial wound infection but was associated with considerable postoperative wound morbidity and the need for additional intervention. However, because the available retrospective records did not consistently document all components required for formal CDC/NHSN classification, the latter group should preferably be described as wound gaping requiring re-suturing rather than categorically labelled as deep incisional SSI.

Few studies report SSI registrations from elective and emergency caesareans separately or apply the CDC criteria. In the report from the Norwegian 'breakthrough project', the incidence of wound infection was as low as 2.2 and 2.7% in the group of women with regional and general anaesthesia, respectively.¹¹ This is in accordance with earlier reports, such as Ehrenkranz et al reporting a wound infection rate of 1.1%, and Nielsen et al reporting an infection rate of 1.6%.^{12,13} But in both reports, the observation time was confined to the hospital stay. However, Couto et al and Tran et al found 9.6 and 9.8%, respectively, SSI when the follow-up period was 30 days after hospital discharge.^{14,15}

The annual trend in the present study is also noteworthy. Although the number of caesarean sections increased progressively from 935 in 2020-2021 to 1,426 in 2023-2024, the corresponding SSI rate declined from 8.1% to 6.8%. The annual number of SSI cases itself was highest during 2021-2022 and subsequently declined. This pattern suggests that increasing surgical volume did not result in a

parallel increase in the SSI rate. However, because this was a retrospective observational study and no formal intervention was introduced or evaluated, the decline cannot be attributed to any single infection-control measure. Improvements in surgical technique, perioperative antibiotic practices, staff experience, infection-prevention practices, postoperative surveillance, or changes in patient characteristics may all have contributed.

The higher SSI burden observed during the earlier years of the study also warrants consideration in the context of the COVID-19 pandemic. The recent global meta-analysis by Mojtahedi et al found that pooled post-caesarean SSI estimates were highest during the COVID-19 period, although considerable heterogeneity existed between regions and studies.² Changes in hospital workload, patient presentation, emergency referrals, staffing, infection-control practices, and follow-up during the pandemic may have influenced SSI surveillance and outcomes. These factors should be considered when interpreting the year-to-year variation in the present study.

Prevention of SSI requires a multimodal approach extending from the antenatal period through postoperative follow-up. The WHO recommends a comprehensive bundle of preoperative, intraoperative, and postoperative measures for SSI prevention. These include appropriate preoperative preparation, timely administration of prophylactic antibiotics, appropriate skin preparation, maintenance of aseptic technique, optimisation of perioperative care, and postoperative wound surveillance.⁶ The 2021 WHO recommendation specifically addressing skin preparation for caesarean section further emphasises evidence-based selection and application of antiseptic agents.⁷

Vaginal preparation before caesarean section is another potentially relevant preventive measure. The earlier manuscript discussed the use of chlorhexidine-based preparations; however, the evidence should be interpreted in accordance with contemporary guidelines rather than assuming superiority of one preparation solely on the basis of antimicrobial activity. Vaginal antiseptic preparation may be considered as part of an institutional SSI-prevention protocol, with the choice of agent and method guided by current evidence and local policy.⁸

The present study has several strengths. It includes a relatively large number of caesarean deliveries over a four-year period and provides longitudinal information regarding SSI occurrence in a secondary-care setting. The study also highlights clinically important wound outcomes rather than focusing solely on the occurrence of infection. Nevertheless, several limitations should be acknowledged. The retrospective design limits the completeness and accuracy of recorded information and precludes determination of causal relationships. The study records did not permit comprehensive evaluation of several established SSI determinants, including emergency versus

elective surgery, duration of surgery, duration of membrane rupture, number of vaginal examinations, diabetes, hypertensive disorders, antibiotic timing, skin-preparation technique, operative blood loss, and microbiological profile. In addition, the risk-factor percentages represent the distribution of documented factors among SSI cases and should not be interpreted as measures of relative risk or independent predictors in the absence of a non-SSI comparison group and multivariable analysis.

Overall, the findings demonstrate that SSI remains a relevant postoperative problem following caesarean section in secondary-care hospitals. The predominance of obesity, anaemia, and previous surgery among documented risk factors is consistent with contemporary evidence. At the same time, the progressive reduction in SSI rate despite increasing caesarean volume is encouraging and may reflect improvements in perioperative and infection-prevention practices. Future prospective studies incorporating standardised SSI definitions, systematic 30-day surveillance, microbiological assessment, and multivariable analysis would help identify independent predictors and evaluate the effectiveness of targeted SSI-prevention bundles in secondary-care obstetric settings.

CONCLUSION

Surgical site infection remains an important and potentially preventable complication following caesarean section, particularly in resource-constrained secondary-care settings. Identification of modifiable patient-related risk factors, meticulous adherence to infection-prevention practices, appropriate perioperative antibiotic prophylaxis, and careful postoperative wound surveillance are essential for reducing SSI-related morbidity. Strengthening institutional infection-control measures, ensuring timely recognition and management of wound complications, and maintaining regular surveillance and audit can contribute to improved maternal surgical outcomes and quality of obstetric care.

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