

A Comparative Study of Surgical Site Infections in Elective and Emergency Caesarean Surgeries

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Conflict of interest: Nil

Abstract:

Background: Surgical Site Infections (SSIs) are a leading postoperative complication, particularly after cesarean sections (C-sections), impacting patient outcomes and healthcare resources. The risk of SSIs is significantly higher in emergency procedures compared to elective surgeries, due to multiple modifiable and non-modifiable factors.

Aim of the study: To study and compare surgical site infections in emergency and elective Caesarean surgeries.

Methodology: This prospective comparative study was conducted on 560 pregnant women undergoing either elective or emergency lower segment cesarean sections (LSCS) at the Government Maternity Hospital, Tirupathi over a one-year period. Participants were assessed preoperatively, intraoperatively, and postoperatively for demographic characteristics, clinical risk factors, and signs of wound infection. Data were analyzed using SPSS v24, with chi-square and t-tests employed for statistical significance.

Results: SSIs were observed in 8.2% (n=23) of emergency LSCS cases versus 1.07% (n=3) of elective LSCS cases. Emergency procedures showed higher association with risk factors like postoperative anemia (39.13%) and obesity (34.78%). *Klebsiella* spp. and *Staphylococcus aureus* were the predominant pathogens isolated in emergency and elective groups, respectively. Wound gaping and need for resuturing were significantly higher in the emergency group.

Conclusion: Emergency LSCS is significantly associated with a higher incidence of SSIs compared to elective procedures. Identifying key risk factors like obesity, anemia, and hypothyroidism, along with targeted antibiotic therapy, can help reduce postoperative infections. Preoperative optimization and standardized infection control protocols are crucial to improving maternal outcomes.

Keywords: Surgical site infection, Emergency caesarean, Elective LSCS, Risk factors, Postoperative wound infection.

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Introduction

SSI-Surgical site infection may be in any anatomic area that was opened or manipulated during a surgical procedure. It may include either the incision or deep tissue at operation site. This would include most of the infections that develop after surgery. It must develop within 30 days of the procedure and be accompanied by one of the following: Diagnosis by either a surgeon or attending physician; An abscess identified clinically or by radiology, Fluid/tissue from wound on culture showing bacterial isolates; Purulent drainage from a drain placed in to the organ/space.

Surgical site infections (SSIs) impact approximately one-third of patients who have had surgery, leading to considerable morbidity and mortality. These infections present a serious threat in terms of both human suffering and financial burden. Cesarean

sections, among the most frequently performed surgeries, are not exempt from these risks. SSIs associated with cesarean deliveries contribute significantly to patient morbidity and mortality, resulting in substantial human and economic losses.

The C-section technique remained relatively crude and the practice did not include surgical suture (stitches) to close the opened womb until the 1870s. In 1876, Eduardo Porro, Professor of Obstetrics advocated removal of the womb itself after C-section as a way of controlling bleeding. Following this, the first caesarean hysterectomy was performed in the United States by Richardson in 1881. In 1882, however, German obstetricians, Adolf Kehrer and Max Sänger each developed methods for preventing uterine bleeding by using suture to close the wound.

“Kehrer” advocated the low horizontal incision over uterus that is still being practised today. This low incision would aid recovery and reduce the risk of death and his incision method became popular in the early twentieth century. With the advent of sterilization, hand washing and antibiotics, the surgical outcomes of C-section improved further still.

Various factors impact surgical wound healing and the likelihood of infection. The primary contributors to SSIs are patient-related (endogenous) and procedural-related (exogenous) variables. Additionally, non-modifiable factors like age and gender also play a role in the high prevalence of SSIs. However, certain modifiable factors, such as maintaining good nutritional status, avoiding tobacco use, appropriate use of antibiotics, and proper intraoperative techniques, can enhance the chances of a successful surgical outcome.

Although microorganisms are present in all surgical incisions, only a small percentage of them really have clinical infections. Many individuals don't develop infections because their intrinsic host defenses are quite good at getting rid of microorganisms from surgical wounds. Either uneventful wound healing or surgical site infection result from the interaction of four key variables. Wound Inoculation with Bacteria, Efficacy of Bacteria to Cause Infection, Microenvironment and Adjuvant Effects of host Innate and Adaptive Immune System.

Need for the study: Surgical site infection-SSI is one of the most common nosocomial infection and acts as an index of the health care system of the institution. It prolongs the hospital stay of the patient and causes social and financial burden to the patient. In spite of aseptic measures, Surgical site infection (SSI) cause an impact over 1/3rd of patients who have undergone a surgical procedure. Therefore, it is necessary to identify the causal factors and take proactive measures to curb the occurrence of SSIs-surgical site infections.

Aim of the study: To study and compare surgical site infections in emergency and elective Caesarean surgeries.

Objectives of the study: To assess the prevalence, various causes and risk factors, the common pathogens implicated for surgical site infections. And to observe and compare the rate of surgical site infections in emergency and elective Caesarean surgeries.

Materials and Methods

This was a prospective comparative study done in 560 pregnant women undergoing elective or emergency Caesarean surgery at government maternity hospital, Tirupati over One year period.

Women who had regular ante natal visits at Government Maternity Hospital, Tirupati. Women undergoing elective or emergency caesarean section. Women who are willing and give consent to participate in the study were included in the study and Women referred in postoperative period for surgical site infections and First visit to the hospital without any previous records were excluded.

Study method: Details of study protocol was explained to subjects. Informed consent was obtained. Demographic details like name, age, marital status, parity, address and others are taken.

Detailed obstetric, menstrual, and medical history of each patient will be taken. Detailed history regarding preoperative period, surgery and postoperative period will be taken. General physical examination, systemic examination, per abdominal and local examination to be done.

Patients were divided into 2 groups based on the mode of surgery-elective and emergency type of surgery. Patients were observed during the postoperative period for signs of wound infection like throbbing pain, tenderness in the wound area, pus or foul smelling discharge from the wound, generalized fever with chills and rigors and foul smelling lochia. Investigations like complete blood cell counts, renal and liver function tests, wound swab for culture and sensitivity, random blood sugars were done. Patient's treatment given at the hospital were noted such as antibiotics administered based on the culture and sensitivity report and resuturing if wound gaping was present.

Analysis: The collected data will be entered in MS Excel spread sheet and analysed by using SPSS software 24.0 version. The difference between proportions will be measured by using chi-square test and the difference between means will be analysed by using unpaired student t-test. Bar and Pie diagrams, Tables will be used to represent data

Results: Surgical site infections were observed among 23(8.2%) cases and 03(1.07%) cases who underwent Emergency LSCS and Elective LSCS respectively.

Table 1: Age Grouping and Parity of Mothers

Age in Years	Emergency LSCS	Elective LSCS
<20	20(7.1%)	06(2.1%)

20-25	167(59.6%)	128 (45.7%)
26-30	81(28.9%)	110(39.3%)
31-35	12(4.3%)	32(11.4%)
36-40	00	04(1.4%)
Total	280	280
Primipara	130(46.4%)	24(8.57%)
Multipara	150(53.6%)	256(91.42%)

Table 2: Repeat Lscs among Mothers

LSCS	Emergency LSCS	Elective LSCS
1 prior LSCS	37(13.21%)	170(60.7%)
2 prior LSCS	210(75%)	92(32.8%)
3 prior LSCS	32(11.4%)	18(6.42%)
4 prior LSCS	1(0.35%)	0

Table 3: Risk Factors among Mothers with Elective Lscs

Risk Factors	No. of cases	Percentage
Hypothyroidism	24	8.57
Rh Negative pregnancy	14	5
Hypertensive disorders on pregnancy	13	4.64
Breech	10	3.57
GDM	6	2.14
Oligohydramnios	3	1.07
DM	3	1.07
Anemia	3	1.07
CPD	2	0.71
Epilepsy	2	0.71
Hyperthyroidism	2	0.71
Placenta previa	2	0.71
Twin pregnancy	2	0.71
Asthma	1	0.35
Atonic PPH	1	0.35
Bicornuate uterus	1	0.35
Precious pregnancy	1	0.35
Heart diseases	1	0.35
IUGR	1	0.35
Resolved DVT	1	0.35
Teenage Pregnancy	1	0.35

Table 4: Risk Factors among Mothers with Emergency Lscs

Risk Factors	No. of cases	Percentage
Hypothyroidism	25	8.92
Rh Negative	8	2.85
Hypertensive disorders on pregnancy	23	8.21
Breech	5	1.78
GDM	2	0.71
Oligohydramnios	7	2.5
Anemia	10	3.57
CPD	5	1.78
MSL	7	2.5
IUGR	5	1.78
Placenta previa	1	0.35
Twin pregnancy	4	1.42
Asthma	1	0.35
Elderly	1	0.35
Atonic PPH	1	0.35
PROM	1	0.35

Table 5: Type of Wound and Discharge among SSI Patients

Type of discharge	Emergency LSCS n=23	Elective LSCS n=3
Purulent	4(17.39%)	1(33.3%)
Seropurulent	3(13.04%)	0
Serous	16(16.56%)	2(66.6%)
Total	23	3
Wound gaping present	3(1.07%)	23(8.2%)
Resuturing	1(0.35%)	17(6.07%)

Table 6: Risk Factors in SSI Patients

Risk factors	Emergency LSCS n=23	Elective LSCS n=3
Null	14(60.86%)	1(33.3%)
Post-operative anemia	9(39.13%)	0
Obesity	8(34.78%)	2(66.6%)
Gestational hypertension	1(4.34%)	0
Rh negative pregnancy	0	1(33.3%)
Non severe preeclampsia	1(4.34%)	0
Hypothyroidism	1(4.34%)	0

Table 7: Pathogens Isolated

Pathogens	Emergency LSCS n=23	Elective LSCS n=3
Null	6(26.08%)	0
E coli	2(8.69%)	0
klebsiella	4(17.39%)	0
Staph aureus	3(13.04%)	3 (100%)
Enterobacter	3(13.04%)	0
Pseudomonas	2(8.69%)	0
Serratia	1(4.34%)	0
Proteus	1(4.34%)	0
Enterococcus	1(4.34%)	0

Table 8: Drugs Used Among Patients

Drugs	Emergency LSCS n=23	Elective LSCS n=3
Cefaperazone sulbactam	9(39.13%)	0
Metranidazole	8(34.78%)	1(33.3%)
Amikacin	16(69.56%)	2(66.6%)
Augmentin	5(21.73%)	1(33.3%)
Piperacillin tazobactam	5(21.73%)	2(66.6%)
Linazolid	5(21.73%)	1(33.3%)
Ciprofloxacin	0	1(33.3%)
Enterococcus	1(4.34%)	0

Discussion

Our study demonstrated a notable disparity in the incidence of surgical site infections (SSIs) between elective and emergency caesarean sections. The results highlight that infections were more common in the emergency LSCS group (8.2%) compared to the elective LSCS group (1.07%). This observation is substantiated by a body of literature that consistently reports a heightened risk of SSIs in emergency caesarean deliveries [Mojtahedi MF et al. (2023), [1] Gomaa K et al. (2021), [2] Ketema DB et al. (2020), [3] Farret TC et al. (2015)]. [4]

For instance, Gomaa K et al. (2021) reported an SSI incidence of 5.34% in their study population, with emergency CS being identified as an important risk factor (AOR 2.16; 95% CI = 1.61–

2.51) [2]. Similarly, Ketema DB et al. (2020) found an overall cumulative incidence of SSIs of 25.4%, with a higher rate among women undergoing emergency procedures (AHR = 1.13, 95% CI: 1.11, 2.43). [3] Vijaya K et al. (2015) also reported a stark contrast in SSI rates between emergency (9.18%) and elective (1.03%) LSCS. [5]

Various factors could account for the increased susceptibility to SSIs in emergency LSCS. One prominent explanation is the presence of increased risk factors in emergency settings, such as prolonged rupture of membranes, chorioamnionitis, and a higher likelihood of intraoperative contamination [Mojtahedi MF et al. (2023), [1] Gomaa K et al. (2021)]. [2] The urgency of emergency procedures may also limit the time available for optimal

preoperative preparation and infection prevention measures. Additionally, factors like increased surgical time and blood loss in emergency LSCS may contribute to a greater risk of SSIs [Gomaa K et al. (2021), Ketema DB et al. (2020)]. [3]

Age and Parity of Mothers: The age distribution of mothers in our study revealed a predominance of women in the 20-25 years age group, followed by those in the 26-30 years group. This aligns with the global trend of increased childbirth in younger age groups. However, we could not find any significant causal relation between age of the participant and the risk of SSIs. This would contrast with some research studies, such as Erritty M Et al (2023), where advanced age of the participant was identified as an important risk factor for SSI development. [6]

In our study, majority of mothers in both elective and emergency LSCS groups were multigravida. This observation is consistent with studies like Nnagbo et al. (2024), which reported a higher prevalence of multigravida women among those undergoing caesarean sections. [7] While our study did not establish a direct link between high parity and SSI risk, it is plausible that the cumulative effects of multiple pregnancies and deliveries could contribute to increased susceptibility to infections. This potential association warrants further investigation in future research.

Prior Cesarean Sections: In this particular study cohort, a notable proportion of mothers undergoing both elective and emergency LSCS had a history of previous cesarean deliveries. The majority of women in the elective LSCS group (75%) had two prior cesarean sections, while the largest proportion of women in the emergency LSCS group (60.7%) had one prior cesarean section. This observation underscores the occurrence of repeat cesarean deliveries in our population, as it is in increasing trend globally.

The causal relation between previous cesarean surgery and the risk of SSIs is well-documented in the literature. Ketema et al. (2020) shows that a history of prior CS was an important predictor of SSI development in their cohort (AHR = 1.21, 95% CI: 1.11, 2.31). [3] This increased risk can be attributed to several factors, including the presence of scar tissue, altered tissue planes, and compromised blood supply at the surgical site. Scar tissue, in particular, can serve as a nidus for bacterial colonization and impair wound healing, making it more susceptible to infection. Additionally, previous surgical trauma may disrupt the normal anatomical barriers and defense mechanisms, further increasing the risk of SSIs.

Risk Factors in Elective LSCS: In our analysis of elective LSCS cases, the predominant risk factors identified were hypothyroidism (8.57%) and Rh-

negative pregnancy (5.0%). Our findings deviate from that of Erritty et al. (2023), where they did not find a relation between maternal diabetes, ethnicity, or previous C-section with higher risk of SSI. [6] This would indicate that the risk profile for SSIs may vary depending on the population and healthcare setting. Furthermore, it can predispose individuals to anaemia, which is a well-established risk factor for SSIs [Johnson A et al. (2006)]. The weakened immune function seen in hypothyroidism may also increase susceptibility to infections. The relation between Rh-negative pregnancy and SSIs is less clear.

Risk Factors in Emergency LSCS: Our analysis of emergency LSCS cases, reveals that hypothyroidism (8.92%) and hypertensive disorders of pregnancy (8.21%) were the most frequent risk factors in the mothers who developed SSIs. This observation aligns with existing literature by Dong H et al (2024) [8] and Gomaa K et al (2021) [2] that highlights the association between these conditions and a higher chance of postoperative complications, including SSIs.

Dong H et al. (2024) in their study found that participants having diabetes mellitus, which shared same kind of underlying pathophysiology with hypothyroidism, had a higher chance of developing post-operative wound infections following C-sections. [8] Hypertensive disorders of pregnancy, such as gestational hypertension and preeclampsia, have also been linked to an elevated risk of SSIs as noted by Gomaa K et al (2021). [2]

Clinical Presentation of SSIs: The clinical manifestations of SSIs, particularly the nature of wound discharge, give a crucial insight into the severity and potential complications of the infection. In our study, serous discharge was the most frequent type observed in both emergency and elective LSCS groups. This deduction resonates with Dong H et al. (2024), [8] who reported a predominance of serous discharge in their study population. However, a notable proportion of patients in the emergency LSCS group also presented with seropurulent and purulent discharge, suggesting a potentially higher bacterial load and increased risk of wound complications.

The clinical implications of different discharge types are significant. While serous discharge may indicate a milder infection, seropurulent and purulent discharge often signify a more severe infection, requiring prompt and aggressive management.

The presence of purulent discharge, in particular, is seen with increased risk of abscess formation, deeper tissue involvement, and systemic infection [Ali Shah SI et al. (2022)]. [9] Therefore, careful assessment of wound discharge characteristics is crucial for early detection and appropriate man-

agement of SSIs, particularly in the emergency LSCS population.

Wound Complications: Wound complications, such as gaping and the need for resuturing, are significant concerns following cesarean deliveries, as they can delay healing, prolong hospital stays, and increase the chance of SSIs. In the study, as illustrated in Table 8, wound gaping was observed more frequently in the emergency LSCS group compared to the elective LSCS group. This observation is similar with Tan et al. (2019), who showed an increased rate of wound complications in emergency surgeries. [1]

Risk Factors in SSI Patients: Our analysis of risk factors in patients who developed SSIs, revealed postoperative anaemia (Hb < 10 g/dL) and obesity (BMI > 30) as the most common factors in both elective and emergency LSCS groups. These features are consistent with numerous studies like Nnagbo et al. (2024), [7] Koirala P et al. (2023), [11] Ousey K et al. (2021), [12] Rouse T et al. (2019) [13] and Johnson A et al. (2006) [14] in the literature that have consistently identified anaemia and obesity as important risk factors for SSIs.

Postoperative anaemia can impair tissue oxygenation, compromise collagen synthesis, and hinder immune function, all of which are vital for proper wound healing. The reduced oxygen availability at the surgical site creates an environment that can favour growth and proliferation of microbes, increasing the risk of infection. **Johnson A et al. (2006)** demonstrated that women with BMI>30-obese women showed higher number of infections than women with a normal body mass index. [14] In obesity, there is an increased amount of adipose tissue, which shows to have a proinflammatory effect and impair immune response. Additionally, the technical challenges of operating on obese patients, such as increased surgical time and difficulty in achieving adequate haemostasis, can further contribute to SSI risk.

Isolated Pathogens: The microbiological profile of SSIs is crucial for guiding appropriate antibiotic therapy and infection control measures. In our study, *Klebsiella* emerged as the predominant pathogen in the emergency LSCS group, while *Staphylococcus aureus* was the sole organism isolated in the elective LSCS group. These findings resonate with previous studies by Dong H et al. (2024), [8] Mojtabehi MF et al. (2023), [1] Chiranth GS et al. (2016) [15] and Vijaya K et al. (2015), [5] highlighting the commonality of these pathogens in SSIs following cesarean sections.

Klebsiella species, specifically the type- *Klebsiella pneumoniae*, are recognized as frequent causative agents of healthcare-associated infections, including SSIs. They are often seen with increased virulence and antibiotic resistance, posing challenges

for treatment. Pradhan et al. (2009) demonstrated a significant reduction in the infection rate by using fusaric acid, underscoring the importance of appropriate antibiotic selection and preventative measures to combat this pathogen. [16]

Staphylococcus aureus, including methicillin-resistant strains (MRSA), is another major contributor to SSIs. Its ability to form biofilms and evade host defenses makes it a formidable pathogen. Gan et al. (2024) found MRSA as a common cause for SSI in both their control and intervention groups, highlighting the need for vigilant surveillance and targeted treatment strategies. [17]

Antibiotic Usage: The selection and administration of antibiotics play a crucial role in the prevention, treatment of SSIs. In this study amikacin was the most frequently used antibiotic in both emergency and elective LSCS groups. This finding aligns with Broumand et al. (2022), who demonstrated a significant reduction in cesarean section infections with the use of prophylactic antibiotics. [18]

Amikacin, an aminoglycoside antibiotic, exhibits broad-spectrum activity against gram-negative bacteria, including *Klebsiella*, making it a suitable choice for empirical therapy in SSIs. However, its use should be judiciously monitored to avoid potential adverse effects and the emergence of resistance. Ali Shah et al. (2022) emphasized the need of selecting antibiotics basing on effectiveness against the identified pathogens and their availability in the hospital setting. [9]

This study, however did not specifically assess the effect of antibiotic stewardship on SSI rates, the available literature shows that appropriate antibiotic use, including prophylactic administration and targeted therapy based on culture and sensitivity results, can significantly reduce the incidence and severity of SSIs [Broumand et al. (2022), [18] Chiranth GS et al (2016)]. [15]

In the future, research must focus on optimizing antibiotic stewardship protocols for cesarean deliveries, considering the risk factors identified in our study and local resistance patterns. Furthermore, exploring alternative approaches such as topical antiseptics, as suggested by Pradhan et al. (2009), may offer additional avenues for preventing SSIs and reducing reliance on systemic antibiotics. [16]

Conclusion

This study shows a significant high incidence of surgical site infections-SSIs after emergency caesarean sections (LSCS) compared to elective LSCS. The identification of specific risk factors, including hypothyroidism, hypertensive disorders of pregnancy, postoperative anaemia, and obesity, underscores the need for heightened vigilance and targeted preventive measures in these vulnerable populations. Furthermore, the distinct microbiolog-

ical profiles of emergency and elective LSCS emphasize the importance of tailoring antibiotic therapy to address specific pathogens prevalent in each setting.

Our findings emphasize the need for comprehensive preoperative risk assessment and optimization of modifiable risk factors to minimize the incidence of SSIs. Implementing standardized protocols for surgical technique and postoperative care, along with judicious antibiotic use, can better the outcomes for mothers undergoing caesarean deliveries. Continued research and surveillance are crucial to further refine our understanding of SSIs and develop innovative approaches to prevention and treatment, ultimately enhancing maternal well-being and reducing the burden of this common postoperative complication.

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