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Original Article

A Retrospective Study of Surgical Site Infections in Patients Undergoing Cesarean Sections in a Tertiary Hospital in Goa

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Abstract

Introduction: Surgical site infections (SSI) following Cesarean section results in an increase in patient morbidity and increases hospital stay, hospital cost, and increases burden on the healthcare system. The purpose of our study was to determine the occurrence of SSI in patients undergoing Cesarean section, identify the risk factors responsible for SSI, and identify common microorganisms responsible for SSI.

Materials and Methods: Retrospective record-based cross-sectional descriptive study over a period of 1 year (January 2024–December 2024). 2004 patients who underwent Cesarean section who developed SSI within 30 days and met the Centers for Disease Control/NHSN criteria were included in this study. Results were tabulated in graphs and tables and the Chi-square value was calculated, and $P < 0.05$ was taken as statistically significant.

Results: Out of 220 Cesarean sections, 82 (4.09%) developed SSI. Risk factors contributing to SSI were multiparity (62.20%), body mass index ≥ 25 kg/m^2 (53.66%), gestational diabetes mellitus (53.66%), previous Cesarean section (58.54%), anemia (54.88%), PROM (53.66%) and duration of surgery more than 40 min (57.32%). *Staphylococcus aureus* was the most common organism isolated (35%). 68.29% cases of SSI were managed by conservative treatment.

Conclusion: Identifying the risk factors and tackling them during the antenatal period and following standard protocols of surgical scrubbing, giving antimicrobial prophylaxis, good post-operative care, and auditing of SSI will help in reducing maternal morbidity and mortality.

Key words: Cesarean section, Deep incisional surgical site infections, Obesity, *Staphylococcus*, Surgical site infections

INTRODUCTION

Cesarean section is one of the most common surgical procedure performed worldwide.[1] Optimal rate of Cesarean section as suggested by the World Health Organization is 10–15% however rate has escalated from 8.5% in 2005–2008 to 21.5% in 2019–2021 as reported by National Health System Resource Centre.[2] Definition of surgical site infections (SSI) is occurrence of infection within 30 days from operative procedure in the part of body where surgery was performed.[1] SSI post-Cesarean section results in increase in duration of hospitalization, cost of hospital stay and increase burden on health care system.[3] Incidence of SSI following Cesarean section varies from 3% to 15%.[3,4] SSI can be categorized into 3 categories: (1) Superficial Incisional SSI. (2) Deep Incisional SSI (3) Organ/Space SSI.[5] Most common microorganisms isolated from SSI include *Staphylococcus*, Streptococci, Enterococci, Lactobacilli, Diphtheroids, *Escherichia coli*, Anaerobic streptococci, Bacteroids, and *Fusobacterium* as per prevalence of microorganisms in a particular health care facility or area.[2,6] Many risk factors are attributable to the occurrence of SSI which include maternal pre-existing co-morbidities, obstetric factors (parity, pre-term rupture of membranes, prolonged labor, meconium stained amniotic fluid, chorioamnionitis, gestational diabetes mellitus

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(GDM), anemia, previous Cesarean section, excessive vaginal manipulation), socioeconomic status and illiteracy. Furthermore, other factors which contribute to SSI include type of wound, emergency or elective procedures, type of anesthesia, abdominal incision type, and overall procedure duration.[2] Manifestation of SSI can be seen as purulent discharge, pain, erythema, induration, local rise of temperature, and fever.[2]

Our study was conducted with the following objectives:
1. To determine the occurrence of SSI in patients undergoing Cesarean section
2. To identify the risk factors responsible for SSI in patients undergoing Cesarean section
3. To identify common microorganisms responsible for SSI.

MATERIALS AND METHODS

Study setting: This study was undertaken in the Departments of Obstetrics and Gynecology and the Department of Microbiology at Goa Medical College and Hospital, Bambolim, Goa. It was record-based retrospective cross-sectional descriptive study. Patients undergoing Cesarean section from January 2024 to December 2024 were included in the study. Sampling done using Convenience sampling methodology.

Inclusion Criteria

Patients with SSI within 30 days of Cesarean section and meeting the Centers for Disease Control (CDC)/NHSN criteria as follows:
1. Febrile morbidity: Fever more than 38°C, occurring on two occasions at least 4 h apart, after the first 24 h following Cesarean section.
2. Superficial incisional SSI: At least one of the following criteria:
   a. Purulent discharge
   b. Organisms isolated
   c. Superficial incision that is deliberately opened by a surgeon and is culture positive or not cultured, and at least one of the following signs and symptoms of infection: pain or tenderness, localized swelling, redness, or heat
   d. Diagnosis of Superficial Incisional SSI by the surgeon or attending physician.
3. Deep incisional SSI: At least one of the following criteria:
   a. Purulent discharge
   b. Deep incision that spontaneously dehisces or is deliberately opened by a surgeon and is culture positive or not cultured, and when the patient has at least one of the following signs or symptoms-fever (>38°C), localized pain or tenderness
   c. An abscess or other evidence of infection involving a deep incision on direct examination, reoperation, histopathologic, or radiologic examination
   d. Diagnosis is made by a surgeon or attending physician.
4. Organ/space SSI: One or more of the following criteria:
   a. Patient has an identified organism cultured from endometrial tissue or fluid obtained during the operation
   b. Diagnosis is made by a surgeon or attending physician based on at least two of the following: Fever (≥38°C) with no other validated causation, purulent drainage from the uterus, abdominal pain or tenderness.

Exclusion Criteria

a. Cases in which the diagnosis of SSI is not based on the CDC/NHSN criteria and where the follow-up extends beyond 42 days
b. Immunocompromised patients, as they would not be generalizable to the entire population, and more susceptible to infection.

The study was carried out over a period of 1 year (January 2024–December 2024).

Data were collected from the Department of Obstetrics and Gynecology from OT records and case papers of patients. Bacteriological data were collected from records from the Department of Microbiology.

Analysis of data was done using the Statistical Package for the Social Sciences software and data were tabulated in the form of tables and graphs. *P*-value was obtained by using the Pearson Chi-square test. $P < 0.05$ was considered statistically significant.

RESULTS

During our study period, there were 4656 deliveries, out of which 2004 were Cesarean sections and 2648 were vaginal deliveries. Out of 2004 Cesarean sections, 985 (49.15%) were Elective Cesarean sections and 1019 (50.85%) were Emergency Cesarean sections. SSI were seen in 82 (4.09%) patients who underwent Cesarean section

As seen in Table 1, 53.66% women who developed SSI belonged to the age group between 21 and 25 years, followed by 34.15% in the age group above 31 years. 17.07% and 2.43% women belonged to the age group between 26 and 30 years and <20 years age group. 68.29% women who developed SSI belonged to rural areas as

compared to 31.71% women who belonged to urban areas. 69.51% women who developed SSI were referred patients and 30.48% women were booked patients.

As seen in Table 2, 62.20% women who developed SSI were multigravida as compared to 37.80% women who were primigravida and this finding was statistically significant with $P < 0.00001$. Women who had a body mass index (BMI) ≥ 25 had a higher chance of SSI (53.66%) as compared to those women who had a BMI < 25 kg/m^2 ($P = 0.000293$, statistically significant association). Furthermore, women who had GDM, previous Cesarean section, anemia, PROM and had surgery duration more than 40 min had higher risk of SSI that is 53.66% versus 46.34%, 58.54% versus 41.46%, 54.88% versus 45.12%, 53.66% versus 46.34 and 57.32% versus 42.68%, respectively. The calculation of Chi-square value revealed that there is a significant correlation between Multigravidity, Obesity (BMI ≥ 25 kg/m^2), GDM, Previous Cesarean section, anemia, PROM, and duration of surgery more than 40 min and development of SSI with $P < 0.05$. However, we did not find a significant correlation between SSI and PIH.

As seen in Table 3, 82.93% SSI were seen in women who underwent Emergency Cesarean sections as compared to 17.07% who underwent elective Cesarean sections, and this was found to be statistically significant with $P < 0.00001$.

As seen in Figure 1, 74.39% women had superficial incisional SSI, 18.29% women had febrile morbidity, 4.88% women had deep incisional SSI, and 2.44% women had organ/space SSI.

As seen in Table 4, the most common organism isolated was CONS (35%), followed by *E. coli* (22%), *Klebsiella* (13%), *Acinetobacter* (6%), and other species, such as *Citrobacter*, *Enterobacter*, Proteus and *Pseudomonas* were isolated from 4% cases. 20% cases of SSI had a sterile wound/discharge swab.

As per the sensitivity pattern, most of the CONS were found to be sensitive to Linezolid, Piperacillin plus Tazobactam. *E. coli* and *Klebsiella* were found to be sensitive

Table 1: Socio-demographic variables of women who underwent Cesarean section

Sr. No.	Variables		
	Age group (years)	Number of cases (*n*)	Percentage
1	<20	2	2.43
2	21–25	44	53.66
3	26–30	14	17.07
4	>31	28	34.15
	Residence		
1	Rural	56	68.29
2	Urban	26	31.71
	Booked/referred		
1	Booked	25	30.48
2	Referred	57	69.51

Table 2: Risk factors for SSI in Cesarean sections

Sr. No.	Risk factors	SSI number (*n*) percentage	Non-SSI number (*n*) percentage	Chi-square statistics (*P*-value)
1	Gravidity			
	a. Primigravida	31 (37.80)	1247 (64.88)	24.9545 (<0.00001)
	b. Multigravida	51 (62.20)	675 (35.12)	
2	Obesity			
	a. BMI < 25 kg/m^2	38 (46.34)	1265 (65.82)	13.1152 (0.000293)
	b. BMI ≥ 25 kg/m^2	44 (53.66)	657 (34.18)	
3	Gestational diabetes mellitus (GDM)			
	a. Yes	44 (53.66)	242 (12.59)	108.4107 (<0.00001)
	b. No	38 (46.34)	1680 (87.41)	
4	Pregnancy-induced hypertension (PIH)			
	a. Yes	25 (30.49)	728 (37.88)	1.8308 (0.176038)
	b. No	57 (69.51)	1194 (62.12)	
5	Previous Cesarean section			
	a. Yes	48 (58.54)	713 (37.10)	15.348 (0.000089)
	b. No	34 (41.46)	1209 (62.90)	
6	Anaemia			
	a. Yes	45 (54.88)	746 (38.81)	8.4948 (0.003562)
	b. No	37 (45.12)	1176 (61.19)	
7	PROM			
	a. Yes	44 (53.66)	24 (1.25)	658.9862 (<0.00001)
	b. No	38 (46.34)	1898 (98.75)	
8	Duration of surgery			
	a. <40 min	35 (42.68)	1221 (63.53)	14.6071 (0.000132)
	b. >40 min	47 (57.32)	701 (36.47)	

SSI: Surgical site infections, BMI: Body mass index

Table 3: Type of Cesarean section and occurrence of SSI

Sr. No.	Type of Cesarean section	Total number (percentage)	SSI number (percentage)
1	Elective	985 (49.15)	14 (17.07)
2	Emergency	1019 (50.85)	68 (82.93)
Chi-square statistic 32.4833			
$P < 0.00001$			

SSI: Surgical site infections

Table 4: Microbiological profile among the surgical site infections patients

Sr. No.	Microorganism isolated	Number (*n*)	Percentage
1.	Coagulase Negative *Staphylococcus*	29	35
2.	*Escherichia coli*	18	22
3.	*Klebsiella*	11	13
4.	Acinetobacter	5	6
5.	Other species	3	4
6.	Sterile (No organism grown)	16	20
	Total	82	100

to Piperacillin plus tazobactam and Cefoperazone plus sulbactam. Acinetobacter was found to be sensitive to Piperacillin plus Tazobactam and Gentamycin.

As seen in Figure 2, 68.29% patients were managed conservatively and 31.70% underwent resuturing.

DISCUSSION

In our study, we observed that SSI occurred in 4.09% patients. Our findings are similar to studies done by Kangan *et al.*[2] who reported SSI rate of 3.49%, Mhaske *et al.*[6] who stated SSI in 4.4% patients, Sowjanya *et al.*[7] who found SSI in 4.7% patients and Priyansha Raj *et al.*[5] who stated SSI in 5.18% patients undergoing Cesarean section.

We found that about two-third of the women (70.73%) in our study who developed SSI were between 20 and 30 years- of age group. This finding may be because most pregnant women belong to this age category. Similar findings were documented by Devi and Durga.[8] (55% women in age group 21–25 years), Basany *et al.*[9] (adjusted relative risk 2.3 times higher found in women <25 years).

We found that more than half of the women (68.29%) who developed SSI were residing at rural areas and 31.71% stayed at urban areas. Devi and Durga[8] stated 71% women who developed SSI were from rural areas. Furthermore, Priyansh Raj *et al.*[5] quoted 59.26% women who developed SSI belonged to rural areas. Prajapati and Modi[3] in their study stated that SSI were 5 times more common in patients staying in rural areas as compared to those who stayed in urban areas.

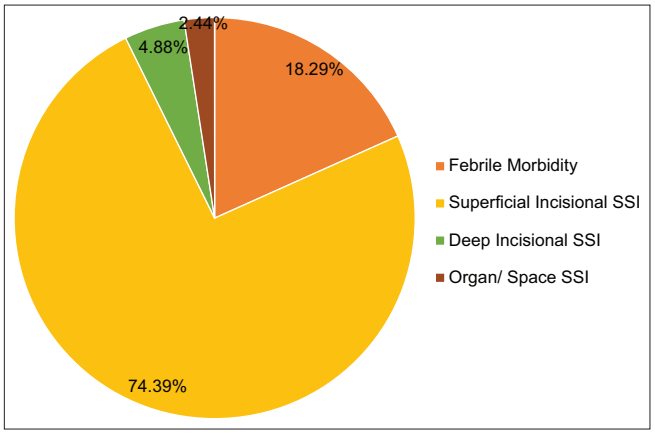

Figure 1: Clinical presentation of surgical site infections

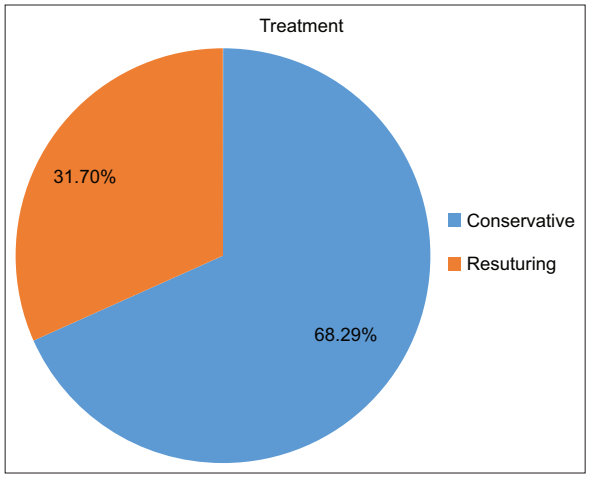

Figure 2: Management of surgical site infections

In our study, most women (69.51%) who developed SSI were referred patients. Similar findings were demonstrated by Sahay and Jhakhar[10] in their study and found SSI in 67.74% referred patients.

In our study, we found that SSI was seen in 53.66% of women who were obese (BMI ≥ 25 kg/m^2) versus 46.34% who were having BMI ≤ 25 kg/m^2 with $P = 0.000293$ (statistically significant). Similar findings were documented by Shanbhag and Veena[11] (58.6% obese women had SSI), Hajira and Korbu[4] (56% obese women had SSI versus 40.3% normal BMI women), Goma *et al.*[12] (16.40 vs. 10.5 [$P < 0.001$]) Dutta *et al.*[13] (Relative Risk 1.758, 95% confidence interval [CI] 1.162–2.687), Prajapati and Modi[3]

(46% obese women had SSI vs. 23.8% normal weight women [$P = 0.01$]) and Sharma *et al*.[14] (31% obese women had SSI). Obesity leads to hypovascular thick subcutaneous tissue, which results in reduced immunity, and also the length of incision is longer in obese women as compared to normal BMI patients.[7]

In our study, we found that the majority of patients (54.88%) who developed SSI had anemia and this relation was found to be statistically significant with $P = 0.003562$. Pre-operative anemia negatively affects the immune status; hence, resulting in SSI. Furthermore, the reason for SSI may be hypoperfusion of the wound in anemia patients. Similar findings were stated by Sharma *et al*.[14] (51.9% SSI patients had anemia) and Devi and Durga[8] (48% SSI patients had anemia).

In our study, we found a statistically significant relationship between Diabetes and SSI. More than half of patients (53.66%) who had GDM developed SSI ($P < 0.00001$). In a study by Shanbhag and Veena,[11] it was stated that diabetes, which is uncontrolled which may be GDM is a predisposing factor for wound infection (14% SSI in diabetic patients versus 5.15% in non-diabetic patients). A study done by Anjali *et al*.[15] also stated that GDM and SSI are significantly associated. (42.2% SSI patients had GDM vs. 3.9% in non-diabetic patients [$P = 0.00001$]).

We found in our study that nearly half of the patients (53.66%) who developed SSI had PROM. We found a statistically significant relationship between PROM and development of SSI with $P < 0.00001$). In cases of PROM and prolonged duration of labor, there is a risk of bacterial colonization, and the liquor also gets infected, leading to the spread of infection to the surgical site and leading to infection. In cases of prolonged labor, the number of per vaginal examinations also increases, hence leading to increased chances of the spread of infection. In a study by Dutta *et al*.,[13] they stated that 28.10% patients who had SSI had PROM (relative risk 1.835, (95% CI–1.299–2.593)). Similarly, Prajapati and Modi[3] in their study documented that 30.8% patients with PROM had SSI versus 8% who didn't have PROM ($P = 0.0001$). A study done by Sahay and Jhakhar[10] had documented SSI in 64.52% patients who were having PROM.

In our study, we found that most of the patients (58.54%) who developed SSI were having previous delivery by Cesarean section and this relationship was found to be statistically significant with $P = 0.000089$. Similar findings were stated by Anjali *et al*.,[15] Prajapati and Modi[3] Sahay and Jhakhar[10] and Mhaske *et al*.[6] who found that 53.6%, 73.1%, 51.61% and 46.42% patients with previous Cesarean section had SSI, respectively.

We found that SSI was more seen in patients who were taken for emergency Cesarean section (82.93%). This finding may be because of less time available to prepare the patient in cases of emergency Cesarean section. Studies done by Anjali *et al*.,[15] Prajapati and Modi[3] and Sahay and Jhakhar[10] documented SSI in 81.2%, 96.1% and 79.03% patients who were taken up for emergency Cesarean section, respectively.

In our study, SSI was more seen in multiparous patients (62.20%). These findings may be attributed to the malnutrition and anemia, which are more prevalent in multiparous patients. Similar findings were stated by Prajapati and Modi[3] (65.4% patients who had SSI were multiparous vs. 34.6% who were primiparous) and Sharma *et al*.[14] who stated 55.7% multiparous patients had SSI in their study.

We had one-third (30.49%) of patients with pregnancy-induced hypertension who had SSI. Similar findings were quoted by Anjali *et al*.[15] (37.8% patients with PIH had SSI vs. 5.86% who didn't have PIH [$P = 0.00001$]), Prajapati and Modi[3] (30.8% patients with SSI had PIH vs. 8.7% who didn't have PIH ($P = 0.001$) and Hajira and Korbu[4] (29.9% patients with SSI had PIH).

We found that more than half of the patients who had SSI (57.32%), duration of surgery was more than 40 min. This may be because in cases of lengthy surgeries, there is an increased risk of bacterial contamination. Similar findings were stated by Dutta *et al*.[13] in their study wherein they found 54.59% patients who had SSI had prolonged surgery (duration exceeding 40 min). Furthermore, in studies done by Sahay and Jhakhar[10] and Sowjanya *et al*.,[7] they found SSI in 56.45% and 67.25% patients, respectively, in whom surgery was prolonged.

The most common type of infection found in our study was superficial incisional type (74.39%). Similar findings were documented by Sowjanya *et al*.[7] wherein they found superficial incisional infection in 73.5% patients.

The most common organism isolated from SSI wounds was *Staphylococcus aureus* (35%), followed by *E. coli* (22%), and *Klebsiella* species (13%). Similar findings were documented by Bijoy Dutta *et al*.[13] (40.54% and 18.65% patients of SSI had *S. aureus* and *Klebsiella* infection, respectively) and Devi and Durga[8] (35% patients with SSI had *S. aureus*).

In our study, more than two-third of patients with SSI (68.29%) were managed conservatively. Similar findings were found by Chimrani *et al*.[1] where they found 82.31% patients being managed conservatively. A study by Devi and Durga[8] documented that 63% patients with SSI were

managed conservatively and Mhaske *et al*.[6] documented that 69.6% patients with SSI were managed conservatively.

CONCLUSION

From our study, we came to know about the prevalent rate of occurrence of SSI following Cesarean section and about the risk factors contributing to SSI. We recommend strict surveillance of modifiable risk factors during antenatal visits, such as diagnosing and correcting anemia, controlling diabetes, correcting malnutrition, and eliminating pre-existing infections, such as urinary tract infections. Second, we would like to recommend following strict aseptic precautions in the operation theatre, proper scrubbing techniques to be followed, use of antimicrobial prophylaxis, and providing good post-operative care. Standard protocols need to be framed to help the obstetric staff to screen and detect various risk factors during the antenatal period and tackle them well in advance. All these measures, along with an audit of SSI, will help in reducing maternal morbidity and mortality and thus eventually help us attain the goal of having a healthy baby and a healthy mother at the end of pregnancy.

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