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Research Article

INCIDENCE AND RISK FACTORS OF SURGICAL SITE INFECTION FOLLOWING CESAREAN SECTION IN A TERTIARY CARE CENTRE IN NORTH KERALA, INDIA

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ABSTRACT

Objectives: To objectives of the study were to study 1) the incidence and maternal determinants (host related) risk factors on post cesarean surgical site infection (SSI) and 2) the influence of labor related and procedure related risk factors on post cesarean SSI.

Methods: This study was conducted in the Department of Obstetrics and Gynaecology, KMCT Medical College, Kozhikode from April 1 to August 31 2021 after clearance from ethical committee in which 153 cases of SSI post cesarean were included in the study.

Results: Educational status of patients had statistically significant association with the development of SSI incidence of SSI (44.4%) and is highest among overweight women. Patients with diabetes and hypertension had increased risk of developing SSI. 72.2% with SSI had duration of ruptured membrane for >8 h and duration of rupture of membrane were significantly associated with development of wound infection. Significant linear association was found between number of prior cesarean and risk of development of SSI (p=0.019). Cesarean with mean operative time >45 min had statistically significant risk of developing SSI. Intraoperative complication like adhesions was a predictor of SSI (p=0.001)

Conclusions: Medical morbidities and increased body mass index being predictors along with prolonged operative time can be properly identified and awareness ensured to prevent and identify post cesarean SSI.

Keywords: Surgical site infection, Caesarean, Risk factors, Incidence, Labor -related, Surgical -site infection.

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INTRODUCTION

Cesarean section (CS) is the most commonly performed major abdominal operations among women in both developed and developing countries. Globally, the CS rate average is approximately 15%. According to the US center for disease control and preventions (CDC), surgical site infection (SSI) is defined as an infection occurring within 30 days after a surgical procedure [1]. It is the proliferation of pathogenic micro-organisms which develops in an incision site either within the skin and subcutaneous fat (superficial), musculo-fascial layers (deep), or in an organ or cavity, if opened during surgery. The risk of developing SSI has significantly decreased in the past three decades mainly due to improvements in hygienic conditions, better use of prophylactic antibiotics, and adherence to standard infection control protocols. SSI is a common postoperative complication and is associated with significant morbidity and mortality. The development of post CS infection depends on many factors including: Wound class, immune status, maternal age, education, SES, parity, body mass index (BMI), comorbidities such as hypertensive disorders, diabetes, and anemia. Pregnancy related and procedure related factors also amount to the development of post CS SSI. This study was conducted to identify the incidence, risk factors associated with SSI among pregnant women undergoing CS in this hospital to formulate an ideal environment to reduce SSI. The objectives are 1) To analyze the incidence of surgical site infection following (CS, 2) to study the maternal determinants (host related) leading to the development of SSI, and 3) to the study the influence of labor related and procedure related risk factors, on post CS SSI.

METHODS

Study design

This is a prospective study to determine incidence, risk factors associated with SSI.

Patients with SSI were identified as per the following criteria. (1) Infection occurring in the first post-operative week during hospital stay, (2) discharge from surgical site, (3) at least one sign of inflammation (indurations, erythema, and local rise of temperature), (4) wound deliberately opened by the surgeon for drainage, and (5) surgeon declares that the wound is infected.

Study setting

This study was conducted in the Department of Obstetrics and Gynaecology, KMCT Medical College, Kozhikode.

Study duration

The study duration was from April 1, 2021, to August 31, 2021.

Sample size

N=Z2 $\alpha/2\times p\times(1-p)\times D$ E2 Z $\alpha/2$=Normal deviate for two tailed hypothesis=1.96 p=proportion from previous studies=56.7% (superficial incisional SSI; Ref Article: Surgical site infection following cesarean delivery: Patient provider and procedure specific risk factors) (3) D=Design effect=1 E=Margin of error=10% N (sample size is)=153 [2].

Selection criteria

Inclusion criteria

1. All patients undergoing CS and attending outpatient department (OPD) for follow-up within 30 day following cesarean delivery
2. Who have given consent to participate in the study.

Exclusion criteria

The following criteria were excluded from the study:

1. Women with wound infection after 30 days following surgery, using the criteria for CDC5 (The CDC and prevention) [3]
2. Cases operated outside this hospital
3. Patients requiring obstetric hysterectomy/any other surgical complication.

Our hospital is a tertiary care center. The precise catchment are difficult to delineate, as women attending our hospital virtually come

from all over Calicut, Malappuram, and Wayanad. About 85–90% of these women are booked in antenatal clinic of KMCT, while 5–10% are booked outside and <3% seek un-booked "emergency delivery." The number of KMCT antenatal care seekers who have domiciliary delivery is nil or considerably negligible. Our hospital is being able to provide complete data records than private hospitals or regular public hospitals relatively small percentage of affluent women come to our hospital. It mainly caters the need of mainly lower and lower middle, mid-middle classes of the population. In addition many private hospitals also refer complicated cases to the hospital. About 90%, those attending the OPD are literate. Majority are with secondary or higher level education and are aware of their rights to health.

Method of data collection

Data were collected using a standardized questionnaire. Data collected included patient characteristics such as age, socio-demographic details, BMI, parity, comorbidities such as GDM, and hypertension; pre-operative data such as labor characteristic such as duration of ROM whether induced or spontaneous, indication for cesarean, whether performed as an emergency or elective procedure [4]. Intraoperative data collected include duration of procedure and intraoperative complications. All women who underwent CS were actively monitored for signs and symptoms of SSI during hospital admission and after discharge (during follow-up in the outpatient clinic) for 30 days (surveillance period) and the relevant information was recorded using a prepared pro-forma meeting the objective of the study after taking informed consent. Detection of SSI during hospital stay or post-discharge (with or without readmission), days to SSI development, culture results were all recorded.

Variables studied

- Host related variables include maternal age, education, nativity, socioeconomic status, BMI Education as well as socio-economic status was assessed by Kuppuswamy' socioeconomic status scale. BMI was calculated with the weight at the time of delivery and BMI >23–27.5 is overweight and those >27.5 is obese
- Pregnancy, labor, and procedure related variables include parity, gestational age, reason for admission, number of prior CS, and maternal comorbidities such as hypertension, diabetes, hypothyroidism, anemia, membrane status, whether ruptured or un-ruptured, mode of onset of labor (spontaneous or induced), cesarean delivery details such as indication for CS, emergency or elective, type of anesthesia and the type of skin incision. Intra-operative complication such as hemorrhage and adhesion was noted. Post-operative anemia is defined according to ICMR classification. According to our institutional protocol, all patients with rupture of membrane are given ampicillin 2 g followed by 500 mg every 6th hourly until delivery. Emergency CS was defined as an operation done for the compelling reason that had not been planned, and an elective cesarean was defined as an operation planned and done when scheduled. Duration of surgery was defined as the time elapsed between skin incision and skin closure.

Statistical methods

All statistical procedures were performed using Statistical Package for the Social Sciences 16.0. All quantitative variables are expressed in mean. Qualitative variables expressed in percentages. Associations of selected variables are statistically tested using appropriate statistical test. Chi-square test and independent sample t-test were used to find the statistical significance. Probability value p<0.05 was considered clinically significant.

Majority of the patient belonged to age group 26–30. The rate of SSI is also highest among 26–30 years of age (Fig. 1).

p=0.324, and is not statistically significant

All the patients are literate and educational status of patient has statistically significant association with the development of SSI (p=0.012) (Table 1).

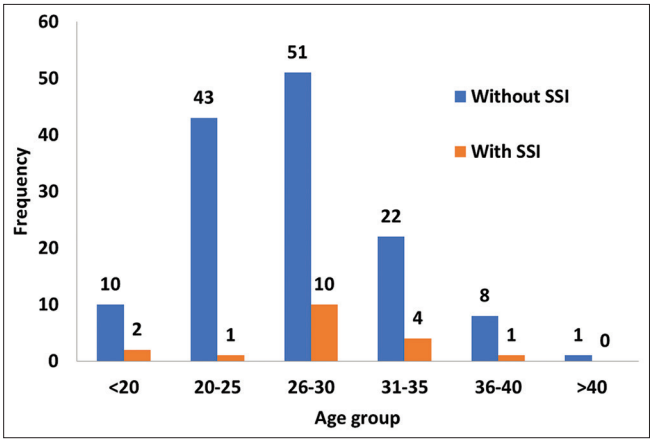

Fig. 1: Age distribution of patients undergoing CS

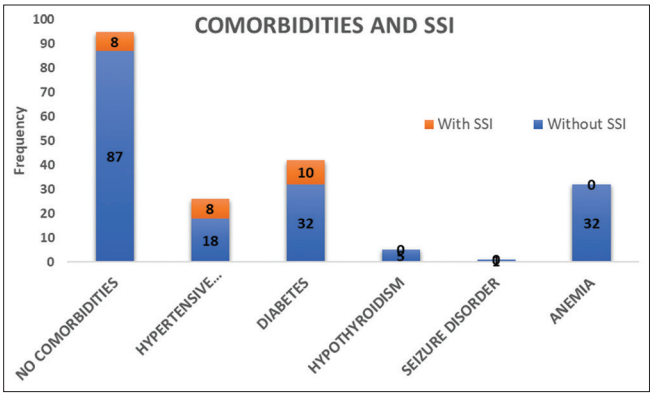

Fig. 2: Distribution of various comorbidities among patient with and without SSI

Socioeconomic status of the study population was mainly confined to lower middle class p=0.099, it is not statistically significant (Table 2).

Parity of the patient is not statistically significant for development of SSI, p=0.821, although Majority of the patients with SSI (66.6%) had or more than one deliveries, and only 33.3% were 1st time mother (Table 3).

Mean gestational age of patients with and without SSI is comparable though not statistically significant, p=0.367 (Table 4).

Incidence of SSI (44.4%) is highest among overweight women. Whose BMI was >23–27.5 kg/m^2, followed by obese patients (33.3%) (Table 5).

Major comorbidity among patient with SSI was diabetes which included both pre-GDM as well as pregnancy associated, followed by hypertension (Fig. 2).

Out of the ten patients with comorbidities ten (100%) had diabetes and was proven statistically significant in the present study, p=0.032 (Table 6).

Ten patients with SSI had associated comorbidities and eight among them had hypertensive disorders and proven statistically significant (Table 7).

In this study, 72.2% (13) with SSI had duration of ruptured membrane for >8 h and duration of rupture of membrane was significantly associated with the development of wound infection (Table 8).

In the present study, 11.1% of those with SSI had intraoperative complication like adhesion and was significantly associated, p=0.001 (Table 9).

DISCUSSION

Most common nosocomial infection following surgery is SSI.

Incidence

Out of the 153 patients who underwent CS when followed up, 18 patients developed SSI. In the present study we had an infection rate of 11.7%.

Authors	Incidence (%)
Wodajo *et al*. [5]	11
Mpogoro *et al*. [6]	10.9
Kondakasseril *et al*. [7]	4.4
Vijayan *et al*. [8]	4.1
De *et al*. [9]	24.2
Present study-2021	11.7

Maternal age

Majority of study population (39.9%) belonged to the age group of 26–30 years, as most pregnant women fall within this age distribution due to early marriage and conception in our population. Mean age in years of subjects with SSI was 27.3 and in those without SSI was 28.33. Age was not a significant factor for the development of wound infection in the present study, as in Zuarez *et al*. [10].

Education

About 72.2% patients with SSI had only intermediate or post high school diploma and only 3% were graduate. This could be attributed to early marriage and earlier conception in these women, which herald their further education. Education has proved to be significantly associated (p=0.012) with the development of wound infection in the present study.

Residence

Majority (77.8%) of SSI patients were from rural areas and only 22.2% belonged to urban areas. No statistically significant association was found due to the fact that, the rural areas have been urbanized in our state of Kerala which is consistent with Devi and Durga [11] and Thakur and Kujur [12] and highlight the need for strengthening ANC at rural areas.

Socioeconomic status

No statistically significant association was noted between socioeconomic status and development of SSI as in Rabiu *et al*. [13] Contrasting findings were noted in Thakur and Kujur [12].

Where patients with the lower socioeconomic status have escalated risk (74.3%).

Parity

In the present study, 66.7% patients with SSI had one or more children whereas only 33.3% were nulliparous similar to a prospective study conducted by Thakur and Kujur This suggests that with increasing gravidity, risk for developing SSI increases by 3.3 folds (p<0.0001). Highest incidence of SSI was observed in multigravida (60.15%), which was further supported by Krieger *et al*. [14].

Devi and Durga [11] and Kawakita and Landy [15] observed that 1st time mothers who underwent primary cesarean has significant association of developing SSI which is in contrast to finding in the present study. SSI was evenly distributed among both nulliparous and multipara as per Kondakasseril *et al*. [7].

Gestational age

Major proportion (55%) of CS was undertaken between 37 and 38 weeks, but only 4 (22.2%) of them developed SSI. Proportion of patients complicated with SSI remains almost similar between 38–39 weeks and 39–40 weeks and could not prove gestational age as a significant factor, consistent with Kondakasseril *et al*. [7]. The mean gestational age in patients with SSI was 37.89 weeks, which is in contrary to the study by Thakur and Kujur [12] where the incidence was highest in post term pregnancies.

Body mass index

Maternal BMI was also an important determinant for the development of SSI. Linear relationship between maternal BMI and SSI was shown by Thakur and Kujur, Kondakasseril *et al*., and Vijayan *et al*. [8] Despite previous reports clearly demonstrating an association between BMI and post-operative infection, this study did not find an significant association between maternal BMI and post CS SSI (p=0.258) which was similar to that by Shree *et al*. [16].

Authors	Incidence (%)
Wodajo *et al*. [5]	11
Mpogoro *et al*. [6]	10.9
Kondakasseril *et al*. [7]	4.4
Vijayan *et al*. [8]	4.1
De *et al*. [9]	24.2
Present study-2021	11.7

Medical risk factors

Proper ANC could provide adequate opportunity for the detection of maternal complication as well as its treatment. All the cases in our study were booked cases and none of the patients who developed SSI were anemic. Kondakasseril *et al*. [7] had contrasting findings as in Vijayan *et al*. [8] and Thakur and Kujur [12]. Diabetes was one of the leading comorbidities among all. Ten (55.5%) patients with SSI had diabetes and were proved as a significant risk factor for the development of SSI (p=0.032) in this study. Hyperglycemia had deleterious effects on host immune function especially on neutrophil function and has a detrimental effect on the process of wound healing. Poor glycaemia during surgery and perioperative period increases the risk of infection. This is supported by Abdallah and Rafeek [17] where women with diabetes mellitus were more likely to develop post-operative SSI than non-diabetic women (with odds ratio 7.384 and p<0.001). In Kondakasseril *et al*. [7] high fasting sugar levels were associated with significant risk of developing SSI (p<0.05).

Authors	p-value
Abdallah and Rafeek [17]	<0.001
Kondakasseril *et al*. [7]	<0.05
Vijayan *et al*. [8]	0.00006
Shukkur *et al*. [18]	<0.001
Scheid-Kofman *et al*. [19]	0.015
Present study 2021	0.032

Hypertension, pre-8isting or pregnancy induced, and related co-morbid states have been significantly associated with SSI in our study p=0.014. Decreased blood flow due to vasospasm of vessels, hypoalbuminemia, and edema may contribute to it. It is similar to that observed by Mpogoro *et al*. [6] where hypertensive disorders of pregnancy (p=0.006), was observed as a significant risk factor for post CS SSI.

Authors	p-value
Mpogoro *et al*. [6]	0.006
Vijayan *et al*. [8]	0.000001
Scheid Kofman *et al*. [19]	<0.001
Shukkur *et al*. [18]	<0.001
Present study 2021	0.014

Although other comorbities such as hypothyroidism and seizure disorder were seen among patients who underwent CS, they were found not to be significant as patients with SSI were not having these comorbidities.

Labor related risk factors

More than half (52.95%) of study population was electively admitted for cesarean. About 30.7% for safe confinement, and others have

Table 1 : Educational status of study population

Education	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
Graduate/PG	23 (17.0)	3 (16.7)	26 (17.0)	0.012
Post-high school diploma	111 (82.2)	13 (72.2)	124 (81.0)	
High school certificate	1 (0.7)	2 (11.1)	3 (2.0)	

Table 2: Distribution according to socioeconomic status

Socioeconomic status	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
Upper middle	18 (13.3)	1 (5.6)	19 (12.4)	0.099
Lower middle	114 (84.4)	15 (83.3)	129 (84.3)	
Upper lower	3 (2.2)	2 (11.1)	5 (3.3)	

Table 3: Distribution according to parity

Parity	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
First time mothers	39 (28.9)	6 (33.3)	45 (29.4)	0.821
1–3	94 (69.6)	12 (66.7)	106 (69.3)	
≥4	2 (1.5)	0 (0.0)	2 (1.3)	

Table 4: Mean gestational age of patients with and without SSI

SSI	n	Mean gestational age	p-value
Without SSI	135	37.60	0.367
With SSI	18	37.89	

Table 5: BMI of patients with and without SSI

BMI	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
Normal weight	20 (14.8)	4 (22.2)	24 (15.7)	0.258
Over weight	87 (64.6)	8 (44.4)	95 (62.1)	
Obesity	28 (20.7)	6 (33.3)	34 (22.2)	

Table 6: Distribution of diabetes among those with and without SSI

DM	Without SSI (n=48) (%)	With SSI (n=10) (%)	Total (%)	p-value
Yes	32 (66.7)	10 (100)	42 (72.4)	0.032
No	16 (33.3)	0 (0.0)	16 (27.6)	

p<0.05 is statistically significant

undergone emergency admission for various reasons such as leaking per vaginum, bleeding per vaginum, abdominal pain, decreased fetal movements, and pre-eclampsia. This study did not find any association between incidence of SSI and onset of labor (p=0.243), although there were 8 (44.4%) cases among those underwent CS before labor, 4 (22.2%) cases which were induced, and 6 (33.3%) cases which had spontaneous onset of labor.

Incidence of SSI (72.2%) was largest amongst those had prolonged duration of rupture of membrane (>8 h) and significant association was established between duration of rupture of membrane and post CS SSI, p=0.001 consistent with the previous report of Thakur and Kujur [12] and Samuel *et al*. [20] and Abdallah and Rafeek [17].

Table 7: Distribution of hypertensive disorder among patients with and without SSI

HTN	Without SSI (n=48) (%)	With SSI (n=10) (%)	Total (%)	p-value
Yes	18 (37.5)	8 (80.0)	26 (44.8)	0.014
No	30 (62.5)	2 (20.0)	32 (55.2)	

p<0.05 is statistically significant

Table 8: Duration of rupture of membrane

Membrane status	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
Not ruptured	93 (68.9)	3 (16.7)	96 (62.7)	0.001
ROM <8 h	11 (8.1)	2 (11.1)	13 (8.5)	
ROM >8 h	31 (23.0)	13 (72.2)	44 (28.8)	

p value; **<0.001 is statistically highly significant

Table 9: Distribution of number of prior CS among those with and without SSI

Number of prior CS	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
No prior CS	53 (39.3)	10 (55.6)	63 (41.2)	0.019
Previous 1 CS	60 (44.4)	2 (11.1)	62 (40.5)	
Previous 2 CS	22 (16.3)	6 (33.3)	28 (18.3)	

p<0.05 is statistically significant. In this study there is linear association between number prior CS and risk of the development of SSI, p=0.019

Table 10: Distribution of the duration of procedure among those with and without SSI

Duration of procedure	Without SSI (n=135) (%)	With SSI (n=18) (%)	Total (%)	p-value
≤45 min	118 (87.4)	9 (50.0)	127 (83.0)	0.001
>45 min	17 (12.6)	9 (50.0)	26 (17.0)	

**p<0.001 is statistically highly significant

Table 11: Distribution of intraoperative complication among those with and without SSI

Intraoperative complication	Without SSI (n=135)	WITH SSI (n=18)	Total	p-value
No complication	134 (99.3)	16 (88.9)	150 (98.0)	0.001
Haemorrhage	1 (0.7)	0 (0.0)	1 (0.7)	
Adhesion	0 (0.0)	2 (11.1)	2 (1.3)	

p<0.05 is statistically significant; **<0.001 is statistically highly significant

This is in contrary to Devi and Durga [11] and Shukkur *et al*. [18] which states that duration of pre-labor rupture of membranes was not found to be significant.

Authors	p-value
Thakur and Kujur [12]	<0.0001
Samuel *et al*. [20]	5.83
Abdallah and Rafeek [17]	9.44
Devi and Durga [11]	<0.05
Shukkur *et al*. [18]	0.056
Present study-2021	0.001

Number of prior CS

Our present study shows significant association (p=0.019) between number of prior CS and risk of development of SSI. Women who

developed SSI were more porous and were more likely to have had a previous CS (Table 9).

Loss of elasticity and changes in skin composition, due to prior CS predispose the individual to SSI. Possibility of complication and prolongation of duration surgery is also anticipated in such cases and is consistent with Krieger *et al.* [14] and Abdallah and Rafeek [17].

Duration of CS

Prolongation of surgery >45 min increased the risk of wound infection by causing breach of sterile techniques, increased blood loss due to complication of surgery, and prolonged exposure to environmental pathogens strengthened in similar findings by Shree *et al.* [16], Abdallah and Rafeek [17], Shukkur *et al.* [18], and Mpogoro *et al.* [13] indicating prolonged duration of operation as significant risk factor; p=0.001 (Table 10).

Intraoperative complication

In the present study, intraoperative complication was recognized as a statistically significant factor for development of SSI with p=0.001. Intraoperative complication like adhesions increases the operative time, increases exposure to environmental pathogens which would ultimately increases the operative morbidity by increasing the chance of post-operative infection (Table 11).

CONCLUSION

Post cesarean SSI is a complex clinical situation, caused by many factors such as patient characteristics, labor related factors and intraoperative factors incidence of SSI in the present study. Educational status of patients had statistically significant association with the development of SSI incidence of SSI (44.4%) is highest among overweight women. Patients with diabetes and hypertension had increased risk of developing SSI. About 72.2% with SSI had duration of ruptured membrane for >8 h and duration of rupture of membrane were significantly associated with development of wound infection. Significant linear association was found between number of prior cesarean and risk of development of SSI (p=0.019). Cesarean with mean operative time >45 min had statistically significant risk of developing SSI. Intraoperative complication like adhesions was a predictor of SSI (p=0.001).

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AUTHOR' CONTRIBUTION

Dr. Hiba has finalized the draft and guarantor, Dr. Heera and Dr. Chellamma has prepared the conceptual framework, designing of draft, and data analysis, Dr. Hiba was involved in data collection and analysis, and Dr. Heera has done manuscript writing. Dr. Hiba and Dr. Abhilash have done data collection.

CONFLICT OF INTEREST

None Declared.

AUTHOR'S FUNDING

None.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee and Institutional Research Committee of KMCT Medical College, Kozhikode.

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