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Original Research Article

Assessment of risk factors for surgical site infection following caesarean section

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ABSTRACT

Background: Assessment of surgical site infection is an important factor to determine the functioning of the health care system. Objectives of this study was to estimate the incidence of surgical site infection among caesarean section cases and to determine the risk factors associated with surgical site infection and comparison with patients having healthy wounds.
Methods: One thousand pregnant women who underwent caesarean section were divided into two groups: Group 1 (cases): Those who had SSI within 30 days of caesarean section and Group 2 (controls): Those who didn't have SSI.
Results: Mean age of group I was 25.35±4.40 and 21.12±3.60 years in group II ($p > 0.05$). Mean gestational age of group I cases was 38.07±1.88 weeks and in group II, it was 38.17±2.06 weeks ($p > 0.05$). A total of 37 (82.5%) women in group I and 931 (96.98%) women in group II underwent emergency caesarean section ($p < 0.05$). In group I, mean duration of surgery was 1.0±0.13 hours and 1.02±0.21 hours in group II ($p < 0.05$). Maximum number of patients i.e. 22 (55%) had wound discharge between 4-7 days followed by 11 (27.5%) between 8-10 days. Mean wound discharge was 7.32±3.45 days in group I. Majority of women, i.e. 27 (67%) found to be sterile in the present study followed by 7 (17.5%) women were found to have staphylococcus aureus. Mean duration of resuturing was 17.42±6.98 days. Mean baby weight in group I was 2.72±0.53 kg and in group II it was 2.95±0.53 kg ($p < 0.001$).
Conclusions: Risk of developing SSI after caesarean section is multi-factorial and found to be influenced by emergency surgery, PROM, pre-operative anaemia, multiple vaginal examinations, interrupted skin suturing, raised BMI, nulliparity, emergency caesarean, duration of surgery.

Keywords: Assessment, Caesarean section, Infection, Risk factors, Surgical site, Surgical site infection

INTRODUCTION

Caesarean section deliveries are one of the most common operative procedures performed by obstetricians. In the United States as of 2017, about 32% of deliveries are by C-section.[1] Caesarean section rates are 26.5% in UK and 32.3% in Australia. In a multicentre collaborative study of Surgical Site Infection (SSI) following CS in the UK, reported an overall wound problem of 13.6% and SSI of 8.9%.[2] Caesarean section falls in clean-contaminated wounds category. Assessment of surgical site infection (SSI) is an important factor to determine the functioning of the health care system in the country. Infectious morbidity after caesarean section can have a remarkable effect on the post-partum women's return to normal function under ability to care for the baby. Women from lower socioeconomic strata are more prone to develop a SSI, thereby resulting in a stressful recovery from caesarean section.

Surveillance is an essential system of measuring SSIs and thereby provides data upon which interventions to

improve patient's safety can be based. The rates of SSI after caesarean section reported in the literature range from 3%-15% depending upon the surveillance methods used to identify infections, the patient population and the use of antibiotic prophylaxis.[3]

Like the developed nations even in developing economies like India, there has been a consistent rise in caesarean section deliveries over the past few decades. World Health Organization (WHO) shows that SSI are most frequently reported type of HAI in low and middle-income countries (LMIC) with a pooled incidence of 11.8 episodes of SSI per 100 surgical procedures. The criteria used to define SSI have been standardized at three different anatomic levels of infection: i) Superficial incisional surgical site infection, ii) Deep incisional surgical site infection and iii) Organ/space surgical site infection.[4]

Following caesarean section, SSI is a major cause for sepsis. Thereby identifying risk factors of SSI is helpful in formulating measures to reduce SSI and thereby sepsis and maternal mortality. Second only to urinary tract infection (UTI), SSI is the most common complication associated with caesarian delivery with reported rates from 3%-15%.[5]

Among the risk factors described for post-caesarean SSI are prolonged labor, premature rupture of membranes, excess vaginal manipulation, manual extraction of the placenta, and premature birth. Comorbidity such as HIV, severe anemia and gestational diabetes are also associated with higher rates of puerperal infection, particularly surgical wound infection. Regarding the glycaemic controls different studies had done glucose estimations differently. It is generally agreed upon that euglycaemia is beneficial in preventing SSI.[6]

Given the importance of these infections, and the lack of any existing national surveillance scheme following caesarean section, it is proposed to develop the study to comprehensively assess the rate of SSI following caesarean through the detection of infections during the initial in-patient stay and through a number of detection methods implemented after discharge. The present study evaluated patients who underwent caesarean section and presented with and without SSI after surgery with the aim of determining risk factors and assessing the impact of antimicrobial prophylaxis on this condition.

METHODS

The present study was a prospective observational study carried out on 1000 pregnant women who underwent caesarean section in the Department of Obstetrics and Gynaecology, Pt. B.D. Sharma PGIMS, Rohtak. A total of 1000 women were enrolled in this prospective study and they were further divided into two groups: Group 1 (cases): Those who had SSI within 30 days of caesarean section. Group 2 (controls): Those who did not have SSI. Finally, a total of 40 cases and 960 controls were included in the present study.

Pregnant women with pre-existing skin infection at surgical site and those with SSI after 30 days of delivery were excluded from the study.

Methodology

Patients were offered to participate in the present study based upon the inclusion and exclusion criterion and an informed consent was sought from all the subjects after explaining the study protocol. After admission, a detailed history and clinical examination was carried out.

All the preoperative risk factors related to the development of SSI were noted in every patient. Antimicrobial prophylaxis with broad spectrum antibiotics was administered 30 minutes prior to caesarean section. Preoperative skin preparation with chlorhexidene gluconate and vaginal cleaning with betadine solution was done in every patient prior to caesarean section. Strict aseptic precautions were followed during caesarean section. The operative procedure and related per-operative factors were observed and recorded in proforma sheet. During the post-operative period, all the patients were closely monitored every day and post operatively i.v. antibiotics (broad spectrum) were given for 48 hours followed by oral medication (broad spectrum). If any symptom or sign of infection appeared during this period, assessment of SSI was done as Superficial Incisional SSI or Deep Incisional SSI or Organ /Space SSI on the basis of criteria given in the modified CDC definition.[6]

If any collection of pus was identified, it was sent for culture and sensitivity. Antibiotics were changed accordingly. Appropriate management was given to each patient of SSI.

Wound was evaluated for development of SSI on third and fifth post-operative day and on the day of discharge. Those women who developed SSI were taken as cases and those who didn't develop SSI within 30 days were treated as controls.

Statistical analysis

Association of each of the potential risk factors with infection as the study outcome was assessed by using Pearson's chi-square test. Comparison of quantitative data was done through Student's *t*-test. Statistical package for social science (SPSS) Version 20 software was used for statistical analysis.

RESULTS

Mean age of group I was 25.35±4.40 and 21.12±3.60 years in group II ($p > 0.05$). Majority of patients were nulliparous i.e. 22 (55%) and 706 (73.54%) in group I

and II, respectively and statistically found to be significant. Most common socio-economic status of the patients found to be lower i.e. 26 (65%) and 681 (70.93%) in group I and II, respectively followed by 5 (12.5%) and 89 (9.27%) upper lower, respectively. Mean body mass index in group I patients was 25.55±3.95 and 24.32±2.99 in group II (p <0.05). Hypertension found to be the most common in both the groups i.e. 5 (12.5%) and 39 (4.06%) in group B with statistically significant difference (p <0.01). Mean gestational age of group I cases was 38.07±1.88 weeks and in group II, it was 38.17±2.06 weeks (p >0.05).

Table 1: Indications of LSCS.

Indications of LSCS	Group I (n=40) Cases	Group II (n=960) control	Statistical significance
Foetal distress	22 (55%)	485 (50.52%)	RR=1.08, OR=1.19, 95% C.I. 0.81 - 1.45, 0.578 NS
Breech with oligohydramnios	4 (10%)	212 (22.08%)	RR=0.452, OR=0.392, 95% C.I. 0.177 - 1.15, 0.06 NS
Contracted pelvis	2 (5%)	15 (1.56%)	RR=3.2, OR=3.31, 95% C.I. 0.757 - 13.52, 0.09
Deep transverse arrest	2 (5%)	4 (0.41%)	RR=12, OR=12.57, 95% C.I. 2.26 - 63.59, <0.0002 Sig.
Prev. LSCS	5 (12.5%)	117 (12.18%)	RR=1.025, OR=1.029, 95% C.I. 0.444 - 2.39, 0.952
NPOL	1 (2.5%)	15 (1.56%)	RR=1.60, OR=1.61, 95% C.I. 0.216 - 11.81, 0.643
Others	4 (10%)	112 (11.66%)	RR=0.857, OR=0.841, 95% C.I. 0.332 - 2.20, 0.747 NS

Table 2: Post-operative findings among two groups.

Findings	Group I (n=40) cases	Group II (n=960) control	Statistical significance
Indwelling catheter	9.89±9.34	9.22±6.45	0.528 NS
Hospital stay	9.47±6.69	5.85±4.02	<0.001 Sig.
History of fever in post-operative period	6 (15%)	39 (4.06%)	RR=3.69, OR=4.16, 95% C.I. 1.66 - 8.21, <0.001 Sig.

Table 3: Type of SSI.

Type of SSI		Group I (n=40) n (%)
Superficial incisional		30 (75%)
Deep incisional		10 (25%)
Wound discharge (days)	<3	2 (5%)
	4-7	22 (55%)
	8-10	11 (27.5%)
	>10	5 (12.5%)
Mean±SD		7.32±3.45
Wound culture sensitivity		
Sterile		27 (67%)
Acinetobacter baumanii, S. Aureus		1 (2.5%)
Coagulase negative *Staph. aureus*		2 (5%)
Enterobacter and *coagulase negative S. Aureus*		1 (2.5%)
Enterobacter and *pseudomonas*		1 (2.5%)
Pseudomonas and *enterobacter*		1 (2.5%)
Staphylococcus aureus		7 (17.5%)

A total of 8 (20%) women in group I and 83 (8.64%) in group II had history of PROM (p <0.01). In group I, mean duration of labour was 8.46±4.09 hrs and 6.97±2.92 hrs in group II (p <0.05). Mean number of pervaginal examination in group I was 2.82±1.80 and 1.85±1.01 in group II (p <0.05). A total of 37 (82.5%) women in group I and 931 (96.98%) women in group II underwent emergency (p <0.05).

Table 1 shows various indications that observed during LSCS. Most common indication in both the groups was foetal distress i.e. 22 (55%) in group I and 485 (50.52%) in group II. Table 2 shows postoperative findings among two groups.

In group I, mean duration of surgery was 1.45±0.23 hours and 1.02±0.21 hours in group II (p <0.05). Pre-operative haemoglobin in group I was 9.35±1.26 g/dl and 9.77±1.39 g/dl in group II. Similarly, post-operative haemoglobin was 8.89±1.23 and 9.32±1.35 g/dl. Mean TSH was found to be 2.16±0.36 and 1.96±0.43. On

statistical analysis, all these parameters of both the groups found to be statistically significant except blood sugar. Table 3 shows type of surgical site infection, wound discharge and wound culture sensitivity observed in the present study.

Amniotic membrane dressing was done in 2 (10%) patients out of 40 patients in group I and in rest 38 (90%) simple dressing was needed. Resuturing was required in 32 (80%) patients in group I and in rest 8 (20%) patients, resuturing was not needed. 23 (71.88%) women required resuturing between 11-20 days followed by 8 (25%) women between 21-30 days. Mean duration of resuturing was 17.42±6.98 days in the present study

Table 4 shows neonatal outcome observed in the present study. Mean baby weight in group I was 2.72±0.53 kg and in group II it was 2.95±0.53 kg (p <0.001).

Table 4: Distribution of cases according to APGAR score.

Apgar score	Group I (n=40) cases	Group II (n=960) control	Statistical significance
1 minute			
0-5	5 (12.5%)	21 (2.18%)	<0.001 Sig.
>5	35 (87.5%)	939 (97.81%)	
5 minutes			
0-5	3 (7.5%)	3 (0.32%)	<0.001 Sig.
>5	37 (92.5%)	957 (99.68%)	
Birth weight	2.72±0.53	2.95±0.53	<0.001 Sig.

DISCUSSION

Incidence of SSI following caesarean section in the present study was found to be 4% which was found to be in accordance with studies of Kondakasseril et al and Vallejo et al.[7,8] Kondakasseril et al carried out a case control study amongst all women who delivered by caesarean section and found that the overall wound infection rate in the study was 3.5%, (50) among 1410 Lower Transverse caesarean section.[7] Vallejo et al, conducted a retrospective, case-controlled, time-matched, quality assurance electronic medical record (EMR) analysis to determine the incidence of surgical site infection (SSI) after caesarean delivery (CD) and identify the risk factors in a rural population and concluded that the incidence of SSI after CD was 7.0%.[8]

In the present study we found that majority of the women developing SSI were of less than 30 years of age. Chhetry et al carried out a prospective observational study and found that most cases of SSI (92%) were seen more commonly in young women of age less than 30 years.[9]

Majority of the women developing SSI were nulliparous i.e. 22 (55%) and 706 (73.54%) in group I and II, respectively. Tran et al reported that the risk factor of surgical site infection was shown to be reduced by 39% and 60% when women had one or more children respectively.[10]

Socioeconomic status of the majority of the patients was in lower class i.e. 26 (65%) and 681 (70.93%) in group I and II, respectively. In our study it was found that risk of SSI is significantly increased in low socioeconomic status group, which is in accordance with the study carried out by Vijayan et al who found that there is significantly increased risk of SSI in the low socioeconomic status group.[11] In a prospective observational study conducted over 300 pregnant women undergoing caesarean section by Dahiya et al found that majority of SSI (62.96%) were in low socio-economic class.[12]

The findings of this study demonstrated that a significant association was present between SSI and BMI and this was in line with other studies. Mean body mass index in group I patients was 25.55±3.95 and 24.32±2.99 in group II (p <0.05). In a prospective study carried out by Canturk et al in 395 surgical patients, 117 nosocomial infections were identified in 96 patients and determined that significant increase in the total number of nosocomial infections was seen in obese patients compared with the normal weight patients (p <0.05) and, that high-density lipoprotein-cholesterol below the 10th percentile increased risk of surgical site infection.[13]

Hypertensive disorders were present in 5 (12.5%) cases of group I and 39 (4.06%) of group II. In this study, patients with hypertensive disorders had significantly increased incidence of SSI. Chhetry et al carried out a prospective observational study in all patients who were admitted with post caesarean SSI or developed SSI during their stay and found that 27.7% of patients with SSI suffered from hypertension.[9]

Majority of the women developing SSI following caesarean were term patients. This was found to be in accordance with the study carried out by Chhetri et al in which 42.6% of patients developing SSI were term patients.[9]

In the present study, we found that a total of 8 (20%) women in group I and 83(8.64%) in group II had history of PROM (p <0.01). Chhetry et al carried out a prospective observational study in all patients who were admitted with post caesarean SSI or developed SSI during their stay were included and their risk factors were studied and found that PROM and multiple vaginal examinations were significantly associated with SSI. PROM was seen in 44.5% of patients developing SSI.[11] In a retrospective study carried out by Rose et al to determine the incidence of SSI and to determine the risk factors for SSI following Caesarean section, the risk of post-caesarean section SSI was greatly increased following labour onset and rupture of membranes, and this risk appeared to be proportionate to the time between rupture of membranes and CS.[14]

In our study we found that prolonged labour significantly led to an increase in SSI following caesarean section. In group I, mean duration of labour was 8.46±4.09 hours and 6.97±2.92 hours in group II (p <0.05). This was found to be in accordance with study conducted by Chhetry et al.[9]

In the present study we found that multiple per vaginal examinations (>3) significantly led to an increase of SSI following caesarean section. This was found to be in accordance with the study carried out by Chhetry et al where it was concluded that more the number of vaginal examinations, more the risk of introduction of infections.[9]

In the present study, it was found that majority of women underwent emergency caesarean section in both the groups. A total of 37 (82.5%) women in group I and 931 (96.98%) women in group II underwent emergency caesarean section (p <0.05). In a similar prospective observational study carried out by Chhetry et al, in all patients who were admitted with post caesarean SSI or developed SSI during their stay were included and their risk factors were studied and concluded that emergency procedures (82.97%) were more likely to develop SSI as compared to elective caesarean (17%).[9]

In the present study, we found that foetal distress was the leading indication for caesarean section cases which resulted in SSI. This was found to be in accordance with the prospective observational study carried out by Chhetry et al, in which 17% of cases of SSI were due to caesarean section for foetal distress.[9]

Type of skin incision has been found to be significantly associated with SSI. According to Killian et al, transverse incision has less chance of wound dehiscence.[7] Devjani et al carried out a prospective study to identify risk factors for SSI following caesarean section and found that univariate analysis indicated that type of skin incision has been significantly associated with SSI. Vertical skin incision was seen in 19.8% of patients developing SSI and had a p-value of <0.05.[15]

In the present study it was found that 19 (47.5%) women out of the 40 developing SSI, had skin closure done with interrupted sutures. The present study identified a higher risk of SSI associated with closure using interrupted sutures rather than continuous subcuticular sutures in the post intervention period even though the numbers were very few. This was found to be in agreement with the prospective study carried out by Choudhary et al in 104 women who had caesarean sections with Pfannenstiel incision for wound outcomes in terms of wound complications (hematoma formation, infection, non-union, dehiscence and need for re-suturing), pain and cosmetic appearance in two groups. With absorbable subcuticular sutures time taken for skin closure was less; approximation was better and without tension. Women were discharged earlier since there was no need for suture removal.[16]

SSI was more common in women in whom surgery duration was more. In group I, mean duration of surgery was 1.45±0.23 hours and 1.02±0.21 hours in group II which was found to be statistically significant (p <0.05). This was found to be in accordance with the study conducted by Chhetry et al where 66% of patient who had SSI had duration of surgery more than one hour.9 Shapiro et al reported that with each hour of surgery the infection rate almost doubles.[17] Devjani et al found 53.3% of patients with prolonged duration of surgery exceeding 45 minutes got infected.[15]

Patients with anaemia were seen to be more prone to SSI. In the present study, pre-operative anaemia was found to be a significant risk factor amongst majority of women with SSI. The mean preoperative haemoglobin in group I was 9.35±1.26 g/dl and 9.77±1.39 g/dl in group II. Pre-operative anaemia was found to be an important predictor of infection as analysed by studies of Waisbren et al and Walter et al.[18,19]

In the present study, with regard to hospital stay of the patients, it was 9.47±6.69 days in group I and 5.85±4.02 days in group II which was found to be statistically significant. The stay in the hospital premises increases patient's susceptibility to hospital acquired infections. In a cross - sectional study carried out by Mitt et al in women developing SSI post-caesarean, it was found that patients with SSI had a longer mean hospitalization time than did non-infected patients (5.8±0.3 versus 7.9±1.5 days; P <.03).[3] Anvikar et al in their study demonstrated an infection rate of 1.76% when preoperative stay was up to one day, which increased to 5% when preoperative stay was more than one week.[20]

The majority of SSIs found in this study were superficial infections accounting for 75%, followed by deep incisional infections 25%. Other studies have also demonstrated that the majority of SSIs after caesarean section are superficial as noted in a study by Amenu et al to determine rates and risk factors for obstetric cases 67% were superficial SSI followed by deep SSI 21.6% and

organ /space 11.4%.[21] Kondakasseril et al carried out a case control study amongst all women who delivered by caesarean section and found that the overall superficial infection was seen in 36 (72%) and deep infection in 12 (24%) and Organ/Space SSI in 2 (4%).[7]

In the present study, we found that majority of SSI post-caesarean section occurred between 4th to 10th post-operative day. The study carried out by Bhadauria et al to find out the incidence of post-operative wound infection among the elective and emergency obstetrics and gynaecological abdominal surgeries showed the appearance of infection between 6th and 10th post-operative days in more than half of the population.[22]

In our study we found that majority of women, i.e. 27 (67%) found to be sterile in the present study followed by 7 (17.5%) women were found to have staphylococcus aureus. Other pathogens included Coagulase negative staphylococci (CoNS), Acinetobacter baumanii, Enterobacter, Pseudomonas. In a study carried out by Wloch et al causative microorganisms were recorded for 39.8% of the infections (157/394). Of these infections, 24.2% (38/157) were reported to be polymicrobial. The most commonly reported pathogen was Staphylococcus aureus (40.4%) of which 17.1% were methicillin-resistant.[23]

Antibiotic prophylaxis is one of the most significant protective factors in decreasing SSI. It is recommended for all caesarean deliveries though role of timing of administration remains controversial. In the present study we found that prophylactic antibiotics were administered to nearly all women for whom information was recorded, the choice of antibiotic administered was based on availability and choice of the surgeon. Most causative organisms reported were common skin or female genital tract flora. Constantine et al carried out a study to compare prophylactic antibiotics for caesarean delivery that are given before the procedure vs at cord clamping and concluded that the antibiotic prophylaxis for caesarean delivery that is given before skin incision, rather than after cord clamping, decreases the incidence of postpartum endometritis and total infectious morbidities, without affecting neonatal outcomes.[24]

In our study amnion dressing was used for treating 2(10%) cases of SSI. Molazem et al carried out a prospective, randomized double-blind clinical trial to determine the effect of an amniotic membrane dressing on caesarean wound healing and found that the application of an amniotic membrane dressing can be helpful in early stage wound healing of caesarean.[25]

In the present study, the mean baby weight in group I was 2.72±0.53 kg and in group II it was 2.95±0.53 kg ($p<0.05$). However, in the study by Vallejo et al, with regard to neonatal outcome, there were no differences with respect to child birth weight, or Apgar scores at birth.[8]

CONCLUSION

The major goal of assessing risk factors for Surgical Site Infection (SSI) following caesarean section is to reduce the various avoidable risk factors resulting in SSI to a bare minimum in order to reduce the risk of morbidity and mortality following surgical site infection in a nursing woman, thereby achieving better perinatal outcome. The results of the study suggest that the risk of developing SSI after caesarean section is multi-factorial and was found to be influenced by the following factors in this study: emergency surgery, PROM, pre-operative anaemia, multiple vaginal examinations, interrupted skin suturing, raised BMI, nulliparity, emergency caesarean, duration of surgery which were found to be statistically significant. Surveillance of SSIs is an important infection control activity. This study showed that post- discharge surveillance is feasible and is important in determining the true burden of SSIs. The detection of SSIs using clinical parameters is feasible in most resource limited settings. Surveillance of SSIs is an important infection control activity.

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