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Original Research Article

Study of Risk Factors for Surgical Site Infection following Caesarean Section in a Tertiary Care Hospital

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Abstract

Introduction: Caesarean section is the most common major abdominal operation performed among women. Surgical site infection (SSI) is the second most common infectious complication following caesarean section. The knowledge of incidence and associated risk factors of SSI after caesarean section will help to increase awareness among health care professionals for prevention of this problem in the hospital.

Aim and Objectives: To assess the frequency of surgical site infection following caesarean section and to assess the risk factors associated with surgical site infection following caesarean section.

Results: The incidence of surgical site infection was found to be 7.2% in our hospital. Most of the SSI were superficial (76.6%), followed by 16.8% of deep and 6.6% of cases were organ space infections. Majority of the patients (84.98%) were unbooked who developed SSI. Higher BMI was associated with an increased risk of development of SSI. Proportion of women with rupture of membranes> 12 hrs and above was more in cases (41.44%) than in controls which was statistically significant. Regarding the microbiologic assessment, 230 cases had positive culture specimen and the most common gram negative isolate found was Escherichia coli (27.5%).

Conclusion: SSI represents a substantial burden of disease both for patients and health care services in terms of morbidity, mortality and economic costs. The identification of risk factors can lead to potential review of practice and subsequent reduction of SSI.

Keywords: Microorganism, Uterus, Wound infection

Introduction

Surgical site infection (SSI) is a type of health care associated infection, in which a wound infection occurs after an invasive (surgical) procedure. SSI are frequent with the incidence varying from 0.5 to 15% depending on the type of operation and underlying patient status [1,2]. Caesarean section is the most common major abdominal operation performed among women in both the developing and developed countries [3]. Surgical site infection is the second most common infectious complication after UTI following caesarean section delivery [1]. The rate of SSI after caesarean section reported in the literature range from 3% to 15% depending upon the surveillance methods used to identify infection, the patient population and use of antibiotic prophylaxis [1,2].

Surveillance for SSI is an important infection control activity which most of the studies on surgical site infection in lower segment caesarean section patients have been conducted outside India. There is a paucity of such data from India. The knowledge of incidence and associated risk factors of SSI after caesarean section will help to increase awareness among health care professionals for prevention of this problem in the hospital. With this background, the study was conducted to assess the frequency of surgical site infection following caesarean section and to assess the risk factors associated with surgical site infection following caesarean section.

Materials and Methods

This hospital based observational study was carried out in the Department of Obstetrics and Gynaecology of King George Medical University, Lucknow in collaboration with the Department of Microbiology for a period of one year after getting approval from Institutional Ethics Committee. All the women undergoing caesarean section and developing SSI based on case definition given by CDC guidelines 2016 [4] were included in the study after getting informed consent. Women who refused to participate in the study were excluded.

Women undergoing caesarean section were examined between day 3 and day 5 and before discharge unless the dressing was soaked before that. If evidence of wound infection was present, it was documented. Dressing was done and pus was sent for culture sensitivity. Clinical information and laboratory investigations required were taken from the interview of the patient, case records and respective resident doctor. Enrolled cases were followed up till discharge where possible and from case records. Patients who were operated on the same day as of cases and who did not develop any discharge or wound gape or other signs of inflammation were taken as controls.

Statistical Analysis

Data was entered in a prestructured proforma and then into Microsoft Office Excel (Microsoft Corporation, Redmond, WA). All continuous data was expressed as mean, standard deviation and median (Inter quartile range) as appropriate. Continuous variables were compared using unpaired student t-test/Mann Whitney U test as appropriate. Categorical variables were expressed as percentages and were compared using chi-square/Fisher's exact test. Multiple logistic regression model were used to measure the magnitude and significance of association between SSI and risk factors. A *P* value of less than 0.05 was considered statistically significant. The data was analyzed with Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS, Inc., Chicago, IL).

Results

During the period, a total of 9202 deliveries took place. Among these, 4565 (50.5%) were vaginal deliveries and 4637 (49.5%) were by lower segment caesarean section (LSCS). Among caesarean deliveries 4340 (93.5%) were emergency procedures and remaining 297 (6.5%) were elective procedures.

In the present study, a total of 333 (33.3%) patients developing surgical site infection were enrolled in the study period.

Correspondingly, twice the number of cases ie., 666 (66.7%) randomly selected women not developing surgical site infection was enrolled as controls. Thus overall incidence of surgical site infection was 3.6% or 36 per thousand during the one year study period. The incidence of surgical site infection in caesarean deliveries was 7.18% or 72 per thousand.

Mean age of cases and controls was 25.97±4.22 and 26.14±3.19 years respectively. Statistically, there was no significant difference between two groups with respect to age. Majority of patients were aged 21-35 years. The odds of SSI were higher in 21-35 and >35 years age group as compared to those aged ≤20 years.

Out of 333 cases, a total of 4 were elective emergencies while 329 were emergency LSCS. SSI was relatively lesser in elective caesarean sections (1.3% or 13 per thousand) as compared to emergency procedures (7.5% or 75 per thousand). All the elective LSCS were booked deliveries. Out of 329 emergency deliveries, a total of 283 (86.02%) were booked and 46 (13.98%) were unbooked. There was a significant association between booking status and emergency LSCS (p<0.001).

Among 666 controls, not developing SSI, a total of 28 were elective and 638 were emergency. The proportion of unbooked deliveries was higher in emergency LSCS (73.35%) as compared to elective LSCS (39.29%). Statistically, this association was significant too (p<0.001). The majority of patients belonged to the nulliparous category in both cases (50.75%) and control (50.90%) but the association with SSI in comparison to patients of higher parity was not statistically significant (p<0.07) (Table 1). In majority of the SSI, the grade was superficial (76.6%) followed by deep (16.8%) and Organ specific (6.6%).

In control group majority of women were in normal weight group (64.11%) as compared to that in case group (46.85%). Proportion of underweight (11.71%) and overweight and obese patients (41.45%) was higher in case group as compared to that in control group (9.91% and 25.97% respectively). (p<0.001). Among cases, patients with monthly per capita income of ≥1350 was 12.01% as compared to 22.68% in control group whereas proportion of those with income 405-1349 was 66.97% as compared to 51.65% in control group, thus higher odds of SSI in income groups 405-809 and 810-1349 as compared to reference income group of >2700. Statistically this association was significant (p<0.001).

The preoperative hospital stay of >3 days was found to be significantly associated with the development of SSI. It was present in 13.51% of cases and 4.35% of controls. Proportion of women with rupture of membranes more than 12 hrs was higher in cases (41.44%) as compared to controls (19.82%). Statistically, the association was significant too (p<0.001).

Anemia had a significant association with the development of SSI with 57.66% of cases found to be anaemic while in the control group 60.51% were normal. A total of 30.03% of cases as compared to 9.16% of controls required transfusion. Thus, the odds of transfusion needs were significantly higher in cases as compared to controls (OR=4.26; p<0.001) (Table 2). Majority of the cases (74.17%) and controls (80.48%) had Pfannenstiel incision. The odds of SSI were significantly lower in Pfannenstiel incision as compared to vertical incision (p<0.02) (Table 3).

Out of 333 specimens sent for culture sensitivity results, a total of 20 (6%) were found to be inadequate/contaminated and hence could not be assessed. A total of 230 (69.1%) were positive and remaining 83 (25.2%) were negative for pathogens. Out of a total of 258 isolates, majority were Gram negative (n=136; 52.7%) while remaining 122 (47.3%) were Gram positive.

Among Gram positive isolates, maximum were CONS (n=64); followed by *Staphylococcus aureus* (n=25), *Enterococcus faecalis* (n=14), *Diptheroids* (n=17) and *Enterococcus faecalis* (n=17). (Table 4). Among 136 Gram negative isolates, maximum (n=71) were *Escherichia coli*, followed by *Acinetobacter* (n=43), *Enterobacter spp.* (n=8), *Proteus mirabilis* (n=4), *Pseudomonas spp.* (n=4), *Citrobacter freundii* (n=2), *Klebseilla pneumoniae* (n=2) and *Pseudomonas aeruginosa* (n=2).

In a multivariate model in which SSI was projected as a dependent variable, all those variables were found to be significantly associated with the outcome on univariate analysis. On binary logistic regression all the variables, were found to be significantly associated with the outcome.

Table 1: Comparison of Parity in Study Population

Parity	Total	Cases (n=333)		Controls (n=666)		Statistical significance	
		No.	%	No.	%	OR	95% CI
P1	508	169	50.75	339	50.90	Ref.	
P2	252	95	28.53	157	23.57	1.21	0.89-1.66
P3	166	42	12.61	124	18.62	0.68	0.46-1.01
P4	43	18	5.41	25	3.75	1.44	0.77-2.72
P5 or more	29	9	2.70	20	3.00	0.90	0.40-2.03
Mean Parity		1.82±1.09		1.75±1.04			

χ^2=8.45; p=0.076 (NS)

Table 2: Comparison of Requirement of Blood transfusion in Study Population

Transfusion need	Total	Cases (n=333)		Controls (n=666)		Statistical significance	
		No.	%	No.	%	OR	95%CI
No transfusion	838	233	69.97	605	90.84	Ref.	
Transfusion reqd.	161	100	30.03	61	9.16	4.26	2.99-6.06

χ^2=71.53; p<0.001

Table 3: Comparison of Type of Incision in Study Population

Type of incision	Total	Cases (n=333)		Controls (n=666)		Statistical significance	
		No.	%	No.	%	OR	95% CI
Pfannnestiel	783	247	74.17	536	80.48	0.70	0.51-0.95
Vertical	216	86	25.83	130	19.52	Ref.	

χ^2=5.21; p=0.022

Table 4: Pathogens isolated from culture positive specimen

Isolate	No. of pathogens	Percentage
Gram Positive	**122**	**47.3**
CONS	64	24.8
Staphylococcus aureus	25	9.7
Enterococcus faecalis	14	5.4
Enterococcus faecium	2	0.8
Diptheroids	17	6.6

Gram Negative	**136**	**52.7**
E. coli	71	27.5
Acinetobacter	43	16.7
Enterobacter spp.	8	3.1
Proteus mirabilis	4	1.6
Pseudomonas spp.	4	1.6
Citrobacter freundii	2	0.8
Klebsiella pneumoniae	2	0.8
P. aeruginosa	2	0.8

Discussion

Surveillance of surgical site infection is an important infection control activity. Early diagnosis and treatment of infection is essential in case of surgical patients. Thus it is crucial that we identify the risk factors responsible for SSI, to improve our standing of variables that influence SSI rates. This shall help in better implementation of infection control protocols and proper surveillance. The present study was aimed at evaluating the incidence of surgical site infection following caesarean section in a tertiary care hospital and to study the risk factors for surgical site infection in a tertiary care hospital over a period of one year.

Surgical site infection has been reported in various hospital settings in different parts of the world but with varied severity. In India, the incidence of post-operative infection following caesarean section in various hospital varies from 6-25% [5,6]. The incidence of SSI in our hospital (7.18%) was comparable to that found in other hospitals in different parts of India. Two studies one from Gujarat (Patel *et al*.,) [7] and other from Guwahati (Talukdar *et al*.,) [5] reported incidence of 6.5% and 6.05% respectively which is comparable to the incidence in our hospital. Similar incidence of 7.4% was observed in a study conducted in Kashmir (Afzal *et al*.,) [8] Another study from a tertiary care hospital from New Delhi reported a SSI rate of 24% which was much higher than our study [6]. This might be due to inclusion of post discharge surveillance as well.

It was observed that 62% and 60% of the cases developing SSI belonged to the age group ≤20 years and >35 years respectively as compared to 31% patient in the reproductive age group. Ageing has been reported to increase the likelihood of post-operative wound infection owing to the decreased immune competence at extremes of age. William *et al* [9] Olson and Lee *et al* [10] reported higher incidence of wound infection in older age group. Majority (84.98%) of the cases had inadequate antenatal visits or no visits at all during the antenatal period (unbooked) and showed to the hospital at the last moment eventually landing up in caesarean section. But however there were a few (15.02%) booked antenatal cases as well which developed SSI post caesarean. The odds of SSI was significantly higher in unbooked cases rather than in booked (OR=2.21, p<0.001). Shreshtha *et al*. found similar results in their study in which 97.7% of patients had previous antenatal visits [11]. Majority of women in both the groups were Para 1. The odds of SSI varied from 0.68 to 1.44 among different parities as compared to Para 1, however, the association was not significant statistically. When we compare the parity in SSI cases in our study, we find that the rate of SSI was higher in multigravida (≥P3-97.8%) as compared to <P3 (70.8%) and the

difference was statistically significant (p<0.001). This can be due to poor nutritional status of the patients with low per capita income and high parity. Similar observation was made by Heethel i. in their study in a tertiary care hospital in rural south India [12]. In the present study incidence of SSI was noticed more in those who had emergency caesarean section (98.7%) as compared to elective (1.3%) and the difference was statistically significant (p<0.001). A study conducted in India also revealed that emergency caesarean section (80.6%) predisposes more to SSI compared to elective [6]. This finding could be attributable to the fact that in emergency cases membrane rupture and multiple per vaginal examinations are frequent. There is also increased risk of bacterial contamination or breaks in the sterile technique or lack of timely antibiotic prophylaxis. In the present study, 76.6% had superficial, 16.8% had deep and 6.6% cases developed organ space SSI. Similar observation was made by Ansar *et al* [13] Patel *et al* [7].

BG Prasad scale (2010) was used for categorising subjects in respective socio-economic groups. Being a tertiary care centre, in our setting a significant number of patients come from the lower socio economic group. In the current study higher odds of SSI was seen inn low income group as compared to high income group (p<0.001). Thus we can say that lower socio economic strata people are predisposed for developing SSI as they have poor sanitation, less access to better health facilities and poor nutritional status as well which adds on the risk of developing infection. In our study 41.45% of patients in the case group belonged to the overweight and obese category whereas the same population was only of 25.97% in the control group. The Odds ratio for overweight being 1.56-2.84 and for obese is 1.48-5.65 and was found to be statistically significant (p<0.001). Similar observations were made by various studies as of Wloch *et al* [14] and Olsen *et al* [15]. Intrinsic tenuous anatomic properties and poor vascularity of adipose tissue and thus decreased oxygen tension, may result in decreased collagen synthesis, decreased capacity to fight infection, and decreased ability to support the necessary mechanisms of the healing cascade. In our current study we found that 13.51% of the cases had a preoperative hospital stay of >3 days while the same population in the control group was found to be only of 4.35% of the patients. The difference was statistically significant (OR=3.59, 95% CI=2.20-5.86 and p<0.001). Similar observations were made by Mpogoro *et al*. in Tanzania [16].

The duration of rupture of membranes either by PROM or during labour is an important factor for SSI as the liquor acts as an inoculum for bacteria which later contribute to SSI. In the present study, the proportion of patients with leaking of 12 hrs or more was 41.44% in cases compared to the control group in which it was only 19.82%. The odds were significantly high in the former group (OR=1.65-3.34) p<0.001 which was statistically significant. The same finding is supported by various other studies such as that of Talukdar *et al* [5] Shreshtha *et al* [11]. In contrast to these studies, study by Ghuman *et al* [17] from New Zealand did not find significant association between elapsed time since rupture of membrane and development of SSI (p=0.2195).

The surgeon may choose either to give vertical or transverse skin incision during caesarean section. It was reported that a transverse (pfannenstiel) incision has less chance of wound dehiscence [18]. In our study univariate analysis indicate increased rate of SSI in women who were given vertical incision (p=0.022). Shreshtha *et al* [11] also found significant positive association between vertical incision and development for SSI. In contrast to these studies Talukdar *et al* [5] and Vermillion *et al* [19] did not report any significant difference in the rate of SSI and type of skin incision.

The present analysis revealed anemia as an important risk factor for SSI development. In this study with increasing grade of anemia, the odds of SSI showed a significant increase ($p<0.001$). Anemia diminishes resistance to infection and is frequently associated with puperal sepsis. Pre-operative anemia is an important predictor of infection and has been proved by several other studies [6,7]. We found a significant association between transfusion of blood products and SSI (30.03% cases vs 9.16% controls $p<0.001$). The relationship between blood products and SSI has been a matter of debate for more than two decades. Several studies have supported the association between the use of blood products and development of post-surgical site infection [20,21]. In our study, pus culture and sensitivity of the micro-organisms from the infected site was studied and 69.1% of the cases reported a positive result while 25.2% were found to have no pathogen and 6% of the specimens were inadequate. Among the positive 69.1% cases 47.3% had gram positive organisms while 52.7% were gram negative. The most common gram positive isolate 24.8% were the commensals of normal skin flora followed by *Staphylococcus aureus* (9.7%). In the gram negative cases 27.5% were of *E. coli* followed by *Acinetobacter* (16.7%).

This is in contrast to the study done by De *et al* [6] in which the most common gram negative isolate was *Acinetobacter* (41%) followed by *E. coli (*24%). In the gram positive group the most common isolate of *Sytaphylococcus aureus.* In the study of Talukdar *et al*. 2015 [13] the most common isolate among all was *Staphylococcus aureus.* (37.96%). In our hospital pre-operative antibiotic prophylaxis was given universally to all the patients undergoing caesarean section. Considering the fact that despite the prophylaxis being given, patients developed SSI, we propose that patients with significant risk factors found in our study for SSI should be given higher antibiotics following caesarean section.

Conclusion

To conclude post-operative abdominal wound infection represents a substantial burden of disease both for patients and health care services in terms of morbidity, mortality and economic costs. All though surgical wound infections cannot be completely eliminated, a reduction in the infection rate to a minimal level may have significant benefits. This can be achieved by an intensive surgical program. The identification of risk factors can lead to potential review of practice and subsequent reduction of SSI. Quarterly analysis and feedback of the data will act as a catalyst for review of practice aimed at reducing post-operative SSI rates. This in long run will drastically reduce the maternal morbidity and mortality due to SSI.

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