Original Article

Incision and prediction of risk factors related to surgical site infection following cesarean section in Chinese women

Qiuxiang Huang[1]*

[1]qiuxianghuang2001@gmail.com

*Corresponding Author

[1]Department of Obstetrics, Wuhan Children's Hospital (Wuhan Maternal and Child Healthcare Hospital), Tongji Medical College, Huazhong University of Science & Technology, Wuhan, Hubei, China

Abstract

Cesarean Section (CS) is one of the most frequently executed surgical procedures in gynecology and obstetrics. After a cesarean section, surgical site infection (SSI) increases hospital stay, lengthens maternal morbidity, and upsurges treatment costs. The current study determines the prevalence and risk factors for surgical site infection following cesarean section in China. A retrospective study was conducted on 23 cases of pregnant women who underwent cesarean section and incision severe infection and detection from March 2017 to January 2020 at Wuhan Maternal and Child Healthcare Hospital in China as the study group, and 20 cases of uninfected cesarean section during the same period were selected as the control group. Data were compared with the controls based on study variables and the presence of SSI. The mean age was 31 ± 2.6. High fever and blood loss were observed in serous SSI-infected patients. The incidence rate of severe surgical site infection was 0.15 %. SSI was observed to be expected in pregnant women who had premature rupture of membrane before surgery ($p < 0.001$), who underwent postoperative antibiotic therapy ($p < 0.001$), and the patients who had gestational diabetes mellitus ($p <0.001$) and hematoma ($p < 0.001$) during surgery. Hence, following a cesarean section, surgical site infection is common. This research discovered several modifiable risk factors. SSI is associated with multifactorial rather than a single one. The development and strict implementation of a procedure by all health care practitioners can successfully reduce and prevent infection rates following cesarean section.

Key words: Cesarean Section, surgical site infection, premature rupture of membrane

Introduction

Parenthood may be a life-changing event. The productive physiological and mental alteration will be compromised when the infant's entry is coupled with recovery from major abdominal surgery and adapting to the torment and inconvenience of an abdominal wound. Cesarean section (CS) might be a regenerative surgical procedure in high and low-income nations having a global range of 6.3 to 27.2% (Ana P Betrán et al., 2007, 2016). Surgical location contamination (SSI) and disease that happens at the operative/incision location within thirty days of the post-surgery. The rate of SSI after CS is estimated from 3.2% to 15.4%, depending on the surveillance strategies utilized to recognize complications, the patient data, and the administration of

antimicrobial drugs (Kuzma, 2016; Vijayan et al., 2016). Maternal irresistible morbidities have been appeared to be 8-fold higher after CS than after vaginal delivery. Due to the constant rise in cesarean conveyances globally, the number of ladies with postpartum contamination is anticipated to extend. The SSI after cesarean area causes physical, mental, and conservative burdens to ladies, family, and the community (Wodajo et al., 2017; Zamudio et al., 2017).

Despite the reality that advancements are made in sterilization strategies, labor room ventilation, surgical strategy, and extensive use of antimicrobial drugs; SSI taking after CS surgeries remains a significant cause of the maternal ailment, more extended hospitalization, expanded therapeutic costs, and maternal mortalities (Victor et al., 2013). Numerous literatures detailed that the incidence of SSI taking after CS depends on diverse components, including wound severity, hypertensive disorders, maternal age, high volume of blood loss, types of CS methods, number of vaginal examinations, maternal age/weight, gestational diabetes mellitus, surgical strategies and premature rupture of membrane (Bhadauria & Hariharan, 2013; Gong et al., 2012; Jalil et al., 2017; Neumayer et al., 2007).

Although the literature has given helpful information about the prevalence of SSI, the evidence obtained from these complications is not generalizable since they were performed in various countries with significant gaps in operating rooms and access to current technical staff. However, findings concerning chance variables unique to China, such as Chinese topographical location and healing center locations, have contradicted widely held beliefs (Cheng et al., 2015; Xiao et al., 2015). The basic technique for understanding the prevalence and spread of healthcare-associated diseases is evaluation, which tracks conditions tentatively and effectively. Site-oriented target observation, commonly used for selected high-risk contaminants and subjects, provides more accurate data. Regardless, a survey in developing nations remains inaccurate and inadequate (Amenu et al., 2011; Wodajo et al., 2017). Over the last few decades, transparent records of SSI obtained through advancing national reconnaissance exercises have been rare in China. Regardless, numerous articles have recorded that SSI reconnaissance at the different hospitals varies widely (Cheng et al., 2015; Guo et al., 2016; Yang et al., 2014).

As a result, this study was carried out to evaluate the incidence and key markers/risk factors of SSI amongst those who received treatment at Wuhan Maternal and Child Healthcare Hospital, China. It is additionally essential to implement an evidence-based prevention strategy for post-CSI in other clinical settings in environments like this one, with similar challenges.

Methodology

Experimental design, population and period

A retrospective case-control study was performed among pregnant patients undergoing cesarian sections between March 2017 and January 2020 at Wuhan Maternal and Child Healthcare Hospital, China. It is one of the centers where expectant moms can get CS administrations. Twenty-three cases of pregnant women who

underwent cesarean section and incision severe infection and detection from March 2017 to January 2020 at Wuhan Maternal and Child Healthcare Hospital in China were selected as the study group, and 20 cases of uninfected cesarean section during the same period were selected as the control group. The distinguish SSI standard agrees with the Center for Disease Control and Prevention (CDC) classification (Horan et al., 1992). Pregnant ladies who were passed on during the surgical strategy or quickly after the procedure or surgical methods performed were excluded from the study.

Sample Collection

Data on socio-demographic variables, gynecological related variables, types of CS, morbidities, biochemical tests, antibiotics given to patients, and risk factors was collected by hospital trained personnel. Generally, the information collection handle was strictly directed by both the doctor and principal examiner. To control and guarantee   the   data   quality, specialized device,   pretest twofold information section and   cross-checked framework were executed.

Variables of the study

Data on socio-demographic variables, gynecological related variables, types of CS, morbidities, biochemical tests, antibiotics given to patients, and risk factors were collected by hospital-trained personnel. Generally, the information collection handle was strictly directed by both the doctor and principal examiner. A specialized device, pretest twofold information section, and cross-checked framework were executed to control and guarantee the data quality.

Statistical Analysis

All included participants were separated into the SSI or the non- SSI groups. Descriptive statistics estimated the socio-demographic characteristics, surgery-related factors, and antibiotic-related factors. Continuous and categorical variables were detailed as means ± Standard deviation and percentages, respectively. Study groups were compared using the Mann-Whitney U-test for continuous variables and the Chi-square test for categorical variables. The significance level was assumed as the conventional of $\alpha = 0.05$ and $P < 0.05$ considered significant. Pearson correlation coefficient (r) and 95% confidence interval were used through simple linear regression analysis to assess the relationship between patients' risk factors linked with SSI. All statistical analyses were done using SPSS software (IBM SPSS v23, NY, USA).

Result

The findings of the demographic characteristics of cases included in the study are listed in Table 1. The incidence of SSI was higher in patients with high-temperature and fever patients before surgery compared to the non-SSI group. Gestational diabetes mellitus, Premature rupture of membranes, hepatitis, and history of the cesarian section were the most mutual comorbidities. The surgical site infected (SSI) group had a significantly extended

full hospital day than the non-SSI group (P < 0.001). Moreover, the surgical site infected group also had a substantially longer postoperative hospital stay than non-SSI (P < 0.001).

The serological findings of patients are summarized in Table 2. The SSI group revealed comparable counts of white blood cells, neutrophils, and hemoglobin at the time of admission. Interestingly, white blood cells, neutrophils counts were increased in postoperative observation compared to the non-SSI group. The concentration of total protein was significantly lower (P < 0.001) in the SSI group when admission to the hospital. The decreased hemoglobin concentration was also evident in the SSI group, which might be linked with excessive blood loss during the CS.

Data related to antibiotic administration are mentioned in Table 3. All the patients received prophylactic antibiotics therapy before surgery. The most commonly used pre-surgery prophylactic antibiotic was 2rd-generation cephalosporin (97.6 %), followed by ornidazole. Post-surgery antibiotics were administered to 25 patients. Cephalosporin was the most frequently used antibiotic (58.1%); combination therapy was also applied to eight patients (18%). Some post-surgery prophylactic antibiotic treatment was less than 7 d; the prevalence of SSI was substantially more pronounced for patients receiving postoperative antibiotic therapeutics for more than seven days than those receiving 1 d or 2-5 days (P < 0.001).

Multiple linear regression analysis was performed to decipher the risk of SSI in patients having a cesarian section. The linear correlation coefficient (r) value in the scatter plot revealed a positive correlation of maternal complications with the SSI. The highest number of SSI cases are linked with a history of CS in both groups, followed by PROM and hypertension. A non-significant correlation was found between combined PROM comorbidities and SSI (P > 0.05).

Table 1: Demographics of Included patients with statistical analysis

Variables, N	Total	Surgical Site infected	Non-Surgical Site Infected	P- value
	43 (100%)	23 (53.5%)	20 (46.5%)	
Age (y), median, IQR	31.0 (29.0-39.0)	32.3 (29.0-35.0)	30.9 (26.0-34.0)	.234
Height (cm)	160.0 (157.0-172.0)	161.0 (157.0-165.0)	160.5 (155.0-165.0)	.767
Weight (kg)	71.5 (63.5-103.0)	75.0 (63.0-87.0)	69.7 (59.0-79)	.145
Gestational period (wk)	39.0 (38.0-41.0)	38.2 (36.0-40.0)	38.8 (37.0-39.0)	.320
Surgery time (minutes)	40.0 (35.0-80.0)	42.4 (34.0-50.0)	39.4 (26.0-52.0)	.371
Blood loss (mL)	400.0 (300.0-800.0)	441.3 (313.0-569.0)	405.0 (291.0-519.0)	.337
Fever time (d)	1.0 (1.0-5.0)	1.39 (0.0-2.0)	0 (0)	< 0.001
Highest temperature (°C)	36.8 (36.8-40.5)	37.8 (36.0-38.0)	36.7 (36.6-36.8)	< 0.001
CPR (0-3 ng/L)	29.5 (14.0-251.0)	75.8 (74.0-76.0)	0 (0)	
PCR (≤0.05 ng/L)	0.12 (0.0-1.3)	0.26 (0.24-0.28)	0 (0)	
Post-surgery SSI (d)	6.0 (5.0-28.0)	6.9 (2.0-10.0)	0 (0)	
Post-surgery hospitalization (d)	8.0 (4.0-36.0)	15.4 (8.0-23.0)	3.9 (3.6-4.2)	< 0.001
Comorbidity (%)				
GDM	6 (13.9%)	4 (17%)	2 (10%)	
Hypertension	2 (4.6%)	2 (8.6%)	0	
PROM	8 (18.6%)	8 (34.7%)	0	
Chorioamnionitis	3 (6.9%)	3 (13.0%)	0	
Hepatitis B	4 (9.3%)	1 (4.3%)	3 (15.0%)	
History of CS	13 (30.2%)	9 (39.1%)	4 (20%)	
Anaemia	1 (2.3%)	1 (4.3%)	0	
Cough	2 (4.6%)	2 (8.6%)	0	

IQR: interquartile range, CS: cesarian section, PROM: Premature rupture of membranes, GDM: Gestational diabetes mellitus

Table 2: Serological findings of Included patients with statistical analysis

Variables, N	Total (n=43)	Surgical Site infected (n=23)	Non-Surgical Site Infected (n=20)	P- value
Before Surgery				
White blood cells (4-10x10^9/L)	8.5 ± 2.6	9.1 ± 2.6	8.2 ± 1.8	.193
Neutrophils (2-7*10^9/L)	124 ± 2.5	7.0 ± 2.3	6.1 ± 1.7	.173
Haemoglobin (113-151g/L)	124.0 ± 12.1	115.9 ± 12.7	112.6 ± 11.8	.393
Total protein (65-85g/L)	62.7 ± 6.8	58.9 ± 6.0	66.2 ± 3.5	< 0.001
Albumin (40-55g/L)	34.2 ± 4.0	32.6 ± 4.2	36.5 ± 1.8	.001
After Surgery				
White blood cells	11.6 ± 3.9	11.1 ± 4.2	10.0 ± 1.6	.283
Neutrophils	8.3 ± 3.7	8.9 ± 3.9	8.0 ± 1.6	.342
Haemoglobin	117.0 ± 19.9	109.9 ± 18.4	103.0 ± 11.7	.194

Table 3: Antibiotic Use and Incision symptoms

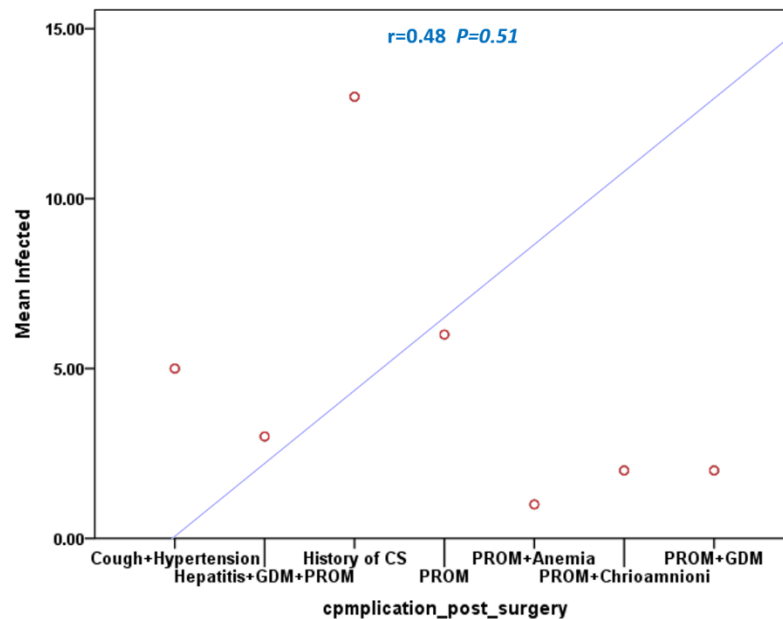| Variables, N	Total (n=43)	Surgical Site infected (n=23)	Non-Surgical Site Infected (n=20)	P- value
Post-surgery antibiotics (%)				< 0.001
Cephalosporin	42 (97.6%)	22 (95.6%)	20 (100%)	
Ornidazole	8 (18.6%)	8 (34.7%)	0	
Azithromycin	2 (4.6%)	2 (8.6%)	0	
Taineng	1 (2.3%)	1 (4.3%)	0	
Levofloxacin	4 (9.3%)	4 (17.3%)	0	
Incision Symptoms (%)				< 0.001
Abscess	23 (53.4%)	23 (100%)	0	
Split	20 (46.5%)	20 (86.9%)	0	
Hematoma	2 (4.6%)	2 (8.6%)	0	

Figure 1: The relationship between maternal complications risk factors and SSI. Simple linear regression was performed to assess relationship based on Pearson's correlation coefficient (r) and P values. PROM: Premature rupture of membranes, GDM: Gestational diabetes mellitus, CS: cesarian section.

Discussion

The current study was devised to decipher how many patients had severe SSI after experiencing CS at Wuhan Maternal and Child Healthcare Hospital, China. After CS delivery, SSI is still one of the leading causes of maternal mortality and morbidity. The total number of CS in the same period in the hospital is 14950. The total cumulative incidence of severe SSI after CS was 0.15 % in this study. This rate is lower than other similar reports because these patients are severe and need to be hospitalized in our research. The incision infection and dehiscence need to be sutured again. Most patients with mild conditions who did not require hospitalization were not counted. The higher incidence rate of SSI has been published in studies conducted globally and particularly in China (Ketema et al., 2020; Mpogoro et al., 2014; Wang et al., 2019). However, as compared to reports from other studies globally, the study's' incidence of SSI in China after CS was higher: United States of America (5.0 %) (Olsen et al., 2008), Norway (8.4%) (Eriksen et al., 2009), Oman (2.6 %) (Dhar et al., 2014), and the United Kingdom (9.7 %) (Wloch et al., 2012). This disparity may be explained by the low sample and hygiene standards followed in developing countries and the absence of infection prevention policies.

The risk of developing an SSI after CS is multi-factorial. The following factors were statistically crucial in this study: blood loss, premature rupture of membranes, history of CS, gestational diabetes mellitus, hypertension, and disrupted skin suturing. These factors aligned with the previous studies based on SSI (Killian et al., 2001; Muganyizi et al., 2008; Shrestha et al., 2014). Usually, amniotic fluid, fetal membranes, and the cervical mucus plug act as barriers to infection during pregnancy. This defensive effect is disrupted when these natural barriers are disrupted, as fluid loses its sterility. The non-sterile amniotic fluid is thought to serve as a transport medium for pathogens that come into contact with skin and uterine incisions, causing chorioamnionitis and its complications (Becher et al., 2009).

Similarly, this research showed that women who had a high fever and attained the highest temperature prone to have an increased risk of surgical site infection after CS delivery. These findings correlate with previously published (Temming et al., 2017; Ward et al., 2008). As previously mentioned, multiple bacteria that cause infection thrive in dirty/contaminated wounds. A prolonged surgery and hospital treatment can increase the risk of pathogen exposure (Leong et al., 2006). Furthermore, due to their poor or depressed immune systems, the elderly and general anesthesia patients cannot have a robust defense against pathogens. Pathogens in the abdominal site maintain an ecological equilibrium in normal circumstances (Kaye et al., 2004; Tsai et al., 2011).

On the other hand, abdominal surgery may disturb the balance and alter bacterial proportion, resulting in an SSI. It was also discovered that preventing SSI in CS patients requires intra-medication administration. In reality, in China, the misuse of antibiotics is a common occurrence. In comparison to post-medication, intra-medication also accounts for a smaller proportion of SSI (Liu et al., 2013). In Chinese hospitals, there is a need to increase the effective use of prophylactic antibiotics.

Additionally, diabetes mellitus was strongly linked to the risk of SSI in our research, mainly if it was preexisting when the danger was doubled. After controlling for Body mass index, duration of surgery, and history of CS, Takoudes et al. discovered that pre-gestational diabetes mellitus increased incision complications post CS up to twofold (Takoudes et al., 2004). When other variables were accounted for in our case-control analysis, diabetes did not increase risk after multivariable logistic regression, where controls and cases did not vary in terms of being diabetic or non-diabetic (Saeed et al., 2019). Similarly, after regression analysis, Olsen et al. found no connection between GDM and SSI in their well-structured case-control research (Olsen et al., 2008). Martens and colleagues discovered that diabetes was linked to an SSI in a sample (Martens et al., 1995).

On the other hand, other studies found no connection between CS and the risk of developing an SSI (Ehrenkranz et al., 1990; Mah et al., 2001). Obesity and the occurrence of a subcutaneous hematoma were all identified as independent risk factors for SSI by Olsen et al. Emmons and colleagues observed substantial variations in the rupture of membranes, labor first stage duration, and the number of vaginal exams after examining sixty wound infections following cesarean section in another case-control study. Nevertheless, UTIs were not linked to wound infections development (Emmons et al., 1988).

A significant drawback of the SSI data used in this analysis is the lack of information on some possible modifiable risk factors for SSI, like maternal parity and BMI. In terms of the concept of SSI, the study encompassed incisional wound infection cases, but there was no information about whether the infection was deep or superficial. Furthermore, using patient data removes pregnant women's hospital discharged before the diagnosis of SSI. Authors could not include women readmitted with SSI because their data did not indicate if they had a CS. The smaller sample size also contributes to the limitations of the current work. However, to the best of our knowledge, this is the effective cohort study to date, looking at the occurrence and risk factors of SSI after CS during an inpatient hospital stay in China. Furthermore, the data set includes information on demographic and clinical dimensions of the hospitalization duration is coded and entered by highly qualified staff.

Conclusion

This research indicates that the SSI rate following CS was significantly lower compared to previously reported studies but since more patients with mild infection are not counted, the actual SSI rate will be higher. Substantial predictors of SSI in this sample included uneducated patients, HIV positive, prior history of CS, vertical incision, emergency surgery, multiple vaginal exams, or membrane rupture before CS. Thus, increased awareness of these risk factors, combined with the creation and strict implementation of protocols, can help reduce and prevent the high rate of SSI following cesarean section. Additionally, offering health education to patients and counseling on avoiding surgical site infections should be considered before and after surgery.

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