The Association Between Preterm Premature Rupture of Membranes and Surgical Site Infection Following Cesarean Section

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ABSTRACT

OBJECTIVE: To evaluate clinical characteristics of surgical-site infections (SSIs) following cesarean section (CS) and to identify infection rates and risk factors associated with SSIs following cesarean section.

STUDY DESIGN: A total of 197 patients who underwent cesarean and complicated with SSIs was evaluated during hospital stay or within 30 days following cesarean section by readmission to the hospital or by post discharge survey. The clinical characteristics, subsequent microbiological culture results and management were recorded.

RESULTS: There were 34 (17.25%) patients complicated with preeclampsia and 26 (13.17%) gestational diabetes mellitus (GDM) in the study group. Preterm rupture of membranes (PROM) rate was 17.31% and mean rupture period were 6.61 hours. In the study population, 66 patients had positive culture results. The most isolated microorganism was *S. Aureus* (n=13, 19.7%). Preeclampsia, GDM and PROM rates were statically significant high in patients with positive culture results ($p<0.05$). There were 31 patients complicated with PROM in the study group. The rates of positive culture results were significantly increased by PROM (mean 45%, $p<0.05$).

CONCLUSION: Independent risk factors for post-cesarean SSIs are younger age, obesity, diabetes, hypertension, premature rupture of membranes. Information regarding higher rates of SSIs should be provided to obese women undergoing cesarean delivery, especially when diabetes and hypertension coexists.

Keywords: Surgical-site infections, Cesarean section, Microbiological, Culture, Premature rupture of membranes

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Introduction

Surgical-site infections (SSIs) following cesarean section (CS) is a leading cause of maternal morbidity and mortality that causes longer hospital stay and increases the costs (1,2). According to the National Nosocomial Infections Surveillance (NNIS) System, the rate of SSI after cesarean section was 2.8% to 6.7%. Previous reports indicated the incidence of SSIs as 0.3% in Turkey and 17% in Australia (3-5). The criteria for defining surgical site infection (SSI), from US Centers for Disease Control and Prevention summarized in figure 1. The risk factors associated with SSIs following the CS are; the maternal pre-operative medical and obstetric conditions (prolonged labor, premature rupture of membranes, excess vaginal manipulation, manual extraction of the placenta, and premature birth), the type of surgical procedure, and the absence of antibiotic prophylaxis (2,6-8).

In current study, we aimed to evaluate clinical characteristics of surgical-site infections (SSIs) following cesarean section (CS) and to identify infection rates and risk factors associated with SSI following cesarean section.

Figure 1: Criteria for defining surgical site infection from Centers for Disease Control and Prevention

Superficial Incisional surgical site infection

Infection occurs within 30 days after the operation and infection involves only skin or subcutaneous tissue of the incision and at least one of the following:

1. Purulent drainage, with or without laboratory confirmation, from the superficial incision.
2. Organisms isolated from an aseptically obtained cıılture of fluid or tissue from the superficial incision.
3. At least one of the following signs or symptoms of infection: pain or tenderrness, localized swelling, redness, or heat and superficlal incision is deliberately opened by surgeon, unless indsion is culture-negative.

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4. Diagnosis of superficial incisional surgical site infection (SSI) by surgeon or attending by physician.

Deep Incisional surgical site infection

Infection occurs within 30 days after the operation and infection involves deep soft tissue (e.g. fascial and muscle layers) of the incision and at least on of the following:

1. Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
2. A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever (>38C), localized pain, or tenderness, unless site is culture-negative.
3. An abscess or other evidence of infection involving the deep incision is found on direct examination, during reooperation, or by histopathologic or radiologic examination.
4. Diagnosis of a deep incisional SSI by a surgeon or attending physician.

Organ/space surgical site infection

Infection occurs within 30 days after the operation and infection involves any part of the anatomy (e.g. organ or spaces), other than the incision, which was opened or manipulated during an operation and at least one of the following:

1. Purulent drainage from a drain that is placed through a stab wound into the organ/space.
2. Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.
3. An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination, during reoperation.
4. DiagnosIs of an organ/space SSI by a surgeon or attending physician.

Material and Method

This cross-sectional study was conducted at Dr. Zekai Tahir Burak Women Health and Research Hospital, Department of Obstetrics from January 2013 to December 2013; this is a tertiary research and education hospital in capital city of Turkey. This is a government-supported hospital, and most of the health services are provided free of charge. A total of 12.000 deliveries and CS are performed annually at current clinic. In this period 3177 pregnancies delivered with cesarean section.

All consecutive women who underwent for caesarean deliveries and developed SSIs were included in the surveillance during the study period. The patients' clinical condition was monitored for a post-operative period of 30 days.

Surgical site infections were diagnosed during hospital stay or within 30 days following CS by readmission to the hospital or by post discharge survey using the criteria of the Centers for Disease Control and Prevention (CDC) NNIS System (5). All of the patients were administered 1 g of cephazoline sodium intravenously as prophylaxis at the time of umbilical cord clamping. The characteristics of SSIs were as presence of purulent discharge from the incision with erythematosus cellulites, indurations or pain, and demonstrable fluid collection noted on ultrasound. The exclusion criteria included stitch abscesses, hematomas and seromas.

When patients with SSIs diagnosed blood and wound discharge specimens were collected and analyzed by Gram stain and culture. Antimicrobial susceptibility testing was performed using a standardized panel which included extended of wide spectrum antibiotics.

Demographic parameters, risk factors for SSIs, co morbidities (e.g., diabetes, preeclampsia, anemia, or chorioamnionitis), and surgical indications were recorded. The study subjects were postoperatively monitored for temperature, SSI, wound and endocervical culture, and antibiotic treatment.

The comparison for this study was conducted according to isolate organism from an aseptically obtained culture of fluid or tissue from the superficial incision and the premature rupture of membranes. The definition of PROM is rupture of membranes before the onset of labor (9). Patients with PROM classified as the study group (n=31; age range=27.15±6.14 years old) and patients without PROM was the control group (n=166; age range=29,58±6,35).

Statistics

Mean and standard deviation (SD) were calculated for continuous variables. The normality of the variables was analyzed by Kolmogorov Smirnov test. Student's t test and Mann Whitney U test have evaluated associations between the categorical and continuous variables. All variables were included in the backward stepwise procedure. Two-sided p values were considered statistically significant at $p<.05$. Statistical analyses were carried out by using the statistical packages for SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

In this cross sectional study, there were 3177 cesarean sections performed among 11278 deliveries (35.4%) during the study period. 197 patients developed incision infections were enrolled the study. The overall infection rate was 6.2% (CI95, 3.8 to 9.6).

The demographic and clinical characteristics of the patients were depicted in table 1. There were 34 (17.25%) patients complicated preeclampsia and 26 (13.17%) patients complicated with GDM in the study group. Prom rate was 17.31% and mean rupture period were 6.61 hours. In the study population, 66 patients had positive culture results. The microorganisms isolated from culture showed in table 2. The most isolated microorganism was *S. Aureus* (n=13, 19.7%). The compression of groups according to the culture results were summarized in table 3. Preeclampsia, GDM and PROM rates were statically significant high in patients with positive culture results ($p<0.05$). There were 31 patients complicated with PROM in the study group. Table 4 summarized the demographic and clinical characteristics of the patients with and without PROM. The rates of positive culture results were significantly increased by PROM (mean 45%, $p<0.05$)

Table 1: The clinical and demographic features of the patients with surgical site infections

	n=197 (mean ± SD)
Age (years)	29.10±0.46
BMI (kg/m^2)	30.48±0.45
Gravidity	2.38±0.12
Parity	1.90±0.09
Preeclampsia (n%)	34(17.25%)
Gestational diabetes mellitus (n%)	26(13.19%)
WBC	12902±544
CRP	28.30±5.11
PROM (n%)	31(17.31%)
Rupture period (hour)	6.61± 4.81
Birth weight	3069 ±55.01
Positive culture result (n%)	66(33.50%)
Hospitalization period (days)	8.2±4.58

BMI: Body mass index, WBC: White blood cell, CRP: C-reactive protein, PROM: Premature rupture of membranes

Table 2: Patients with positive culture results

Isolated microorganism	n	%
n=66		
Staphylococcus aureus	13	19.7
Klebsiella pneumoniae	9	13.7
Escherichia coli	27	40.9
Proteus mirabilis	5	7.5
Enterococcus faecalis	2	3.0
Morganella morganii	1	1.5
Enterobacter cloacae	6	9.2
Pseudomonas aeruginosa	2	3.0
Candida spp.	1	1.5
Total	66	100

Table 3: Comparison of patients with and without positive culture results

	Culture + (n=66)	Culture - (n=131)	*p*
Age (years)	29.66±6.61	28.81±6.41	0.387*
BMI (kg/m^2)	31.93±7.97	29.76±5.35	0.025*
Gravidity	2.24±1.89	2.45±1.74	0.427*
Parity	1.77±1.34	1.96±1,26	0.314*
Preeclampsia (n%)	19(28.78%)	15(11.45%)	0.001**
Gestational diabetes mellitus (n%)	17(25.75%)	9(6.87%)	0.001**
WBC	13686±9028	11134±3028	0.042*
CRP	86.42±102.44	70.53±86.26	0.001*
PROM (n%)	14(21.21%)	17(12.97)	0.001**
Rupture period (hour)	6.81±4.13	3.82±1.92	0.001*
Birth weight	3143±855	3032±726	0.344*

BMI: Body mass index, WBC: White blood cell, CRP: C-reactive protein, PROM: Premature rupture of membranes
** p value was calculated by using independent samples t test, **Chi-square value was calculated by using Kruskal Wallis test*

Table 4: Comparison of patients with and without premature rupture of membranes

	PROM+ (n=31)	PROM- (n=166)	*p*
Age (years)	27,15±6,14	29,58±6,35	0,124*
BMI (kg/m^2)	29.27±5.70	30.71±6.52	0.252*
Gravidity	1.74±1.63	2.50±1.80	0,029*
Parity	1.41±1,17	1.99±1.29	0,023*
Preeclampsia (n%)	9(29.03%)	25(15.06%)	0.001**
Gestational diabetes mellitus (n%)	7(22.58%)	19(11.44%)	0.001**
WBC	13755±7027	11025±5043	0.041*
CRP	87.31±100.54	47.82±70.82	0.038*
Culture + (n%)	14 (45%)	52(31%)	0.001**
Birth weight	2823±713	3115±775	0,017*

*PROM: Premature rupture of membranes, BMI: Body mass index, WBC: White blood cell, CRP: C-reactive protein, * p value was calculated by using independent samples t test, **Chi-square value was calculated by using Kruskal Wallis test*

Discussion

Surgical side infections are a common surgical complication among patients delivered with cesarean section. Further it caused to increase stay of hospital and the cost of treatment. Most caesarean section wound infections are superficial and causes a significant effect to the health system affecting a high number of women who undergo this type of surgery. In this study, we evaluated 197 surgical side infections following caesarean section. Our overall infection rate was 6.2%. There were 34 patient complicated with preeclampsia and 26 patients complicated with gestational diabetes mellitus. The mean hospitalization period was 8.2 days. In the study group there were 31 pregnancies complicated with PROM and 66 patients had positive culture results. We performed two subgroup analysis according to patients complicated with PROM and developed positive culture results. In culture positive group GDM and preeclampsia rates, body mass index (BMI), c-reactive protein (CRP) levels and membrane rupture period were significantly increased. Gravidity, parity, white blood cell (WBC) levels and birth weight were similar. And also in Prom group GDM and preeclampsia rates, WBC, CRP levels and positive culture results were significantly increased but ages and BMI were similar. Prom group had lower gravidity and parity.

To identify the development of post-caesarean surgical side infection at least two mechanisms were determined. First, increased amniotic fluid and wound colonization by cervicovaginal flora due to elongated rupture of membranes. The second is increased exogenous bacterial contamination by skin flora due to breaks in sterile technique, often complicated with difficult or emergency surgery (10).

The common provoking organism of post-caesarean surgical side infection in our study was *S. aureus*. The reported rate of surgical side infection after caesarean section ranges widely, largely because of different risk factors among diverse patient populations. In currently studies, mean rate of surgical side infection after caesarean section was found to be 10% among patients not treated prophylactic antibiotics (11,12).

Kathryn Chu et al. (13) reported in their samples a 7.3% ratio of SSI; however the rate in our sample was 6.2%. Underestimation of surgical side infection rates has always been a concern as some clinics send comparatively few swabs to the laboratory for examination; consequently, any measure of infection that depends on routinely analyzed swabs is likely to underestimate the actual level. Likely, SSIs may occur later after discharge from hospital, since patients delivered with caesarean section usually have a relatively short stay (14).

Risk factors were identified in order to reduce SSIs. Younger age was found to be related with SSI. A recent study in England also showed an increased risk SSI for younger women (15). Premature rupture of membranes was associated with SSI which has also been shown in other studies (16-18). In our study, we also showed that patients complicated with PROM have also associated with positive culture results. Further, in PROM group preeclampsia and gestational diabetes mellitus were more common and WBC and CRP levels have an increase in the group.

The incidence of post-caesarean SSI has been found to be higher following emergency rather than elective caesarean section, in general ward rather than private ward cases (19), The disinfection of the surgical side around the caesarean incision before skin closure has been reported to reduce the incidence of surgical side infection, but no benefit from the use of adhesive plastic drapes could be demonstrated (20,21). Recent studies demonstrated that antibiotic irrigation is safe, however regarding no noted adverse effects, and is an effective method to decrease post-caesarean section infectious morbidity and SSIs (22).

In conclusion, independent risk factors for post-cesarean SSIs are younger age, obesity, diabetes, hypertension, premature rupture of membranes. Information regarding higher rates of SSIs should be provided to obese women undergoing cesarean delivery, especially when diabetes and hypertension coexists.

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