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Evaluation of risk factors for surgical site infection after cesarean section

Sezaryen sonrası yara yeri enfeksiyonu için risk faktörlerinin değerlendirilmesi

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Abstract

Aim: Surgical site infection after cesarean section is an important and common health issue. Although there are several studies researching risk factors in the literature, limited data is present evaluating these factors in the Turkish population. In this study, we aimed to determine the risk factors and provide management protocols for the Turkish population.

Methods: In this retrospective case-control study, 76 patients between 16-45 years of age who underwent cesarean section and were hospitalized for surgical site infection within 6 weeks and 149 patients who had no postpartum infection between June 2016 and December 2017 were included. Sociodemographic features, laboratory parameters, comorbid diseases and surgical characteristics were recorded. SPSS 21.0 was used for statistical analysis and *P*-value <0.05 was considered statistically significant.

Results: The rate of surgical site infection requiring hospitalization was 1% (76/7590). In the infection positive group, body mass index and fasting blood glucose levels were higher (*P*<0.001 and *P*=0.021). Moreover, preoperative hemoglobin was lower and surgery time was longer in this group (*P*<0.001 and *P*=0.005). In logistic regression analysis, the risk of surgical site infection was found to increase by 1.4-fold with increased body mass index (OR 1.463, 95%CI 1.273-1.681, *P*<0.001) and 1.2-fold with higher fasting glucose level (OR 1.21, 95%CI 1.16-1.37, *P*=0.007). Patients with shorter surgery time (OR 0.749, 95%CI 0.709-0.789, *P*=0.010) and high preoperative hemoglobin levels (OR 0.532, 95%CI 0.408-0.695, *P*<0.001) had decreased infection risk.

Conclusion: The risk factors of surgical site infection after cesarean section are generally modifiable. Thus, healthcare providers should inform patients for postpartum infection and risk factors during pregnancy and eliminate these factors if possible.

Keywords: Cesarean, Risk factors, Surgical site infection

Öz

Amaç: Sezaryen sonrası gelişen yara yeri enfeksiyonu önemli ve sık bir sağlık sorunudur. Literatürde ilişkili risk faktörlerini gösteren çalışmalar mevcut olmakla birlikte Türk popülasyonunda sezaryen sonrası yara yeri enfeksiyonu için risk faktörlerini değerlendiren çok kısıtlı veri bulunmaktadır. Çalışmamızın amacı toplumumuzdaki bu risk faktörlerini belirlemek ve önleyici protokoller geliştirmek için veri sağlamaktır.

Yöntem: Bu retrospektif olgu-kontrol çalışmamıza Haziran 2016-Aralık 2017 tarihleri arasında hastanemize başvuran, 16-45 yaşında ve kliniğimizde sezaryen olup postpartum 6 hafta içinde yara yeri enfeksiyonu nedeniyle yatış yapılan 76 hasta ile takiplerinde herhangi bir enfeksiyon bulgusu saptanmayan 149 hasta dahil edildi. Hastaların sosyodemografik özellikleri, laboratuvar parametreleri, ek hastalık varlığı ve cerrahi özellikleri kaydedildi. İstatistiksel analizler için SPSS 21,0 programı kullanıldı ve *P*<0,05 değeri anlamlı kabul edildi.

Bulgular: Hastane yatışı gerektiren yara yeri enfeksiyonu oranımız %1 (76/7590) olarak bulundu. Risk faktörleri açısından değerlendirildiğinde vücut kitle indeksi ve açlık kan şekeri yara yeri enfeksiyonu olan grupta anlamlı olarak yüksek bulundu (*P*<0,001 ve *P*=0,021). Yine bu grupta preoperatif hemoglobin değerleri daha düşük bulunurken, cerrahi süresi ise daha uzun idi (*P*<0,001 ve *P*=0,005). Lojistik regresyon analizinde vücut kitle indeksi artışının enfeksiyonu 1,4 kat (OR 1,463, %95 CI 1,273-1,681, *P*<0,001), açlık kan şekeri yüksekliğinin ise 1,2 kat (OR 1,21, %95 CI 1,16-1,37, *P*=0,007) arttırdığı gösterildi. Ayrıca cerrahi süresinin kısalmasının (OR 0,749, %95 CI 0,709-0,789, *P*=0,010) ve preoperatif hemoglobin değerindeki artışın (OR 0,532, %95 CI 0,408-0,695, *P*<0,001) riski azalttığı saptandı.

Sonuç: Sezaryen sonrası gelişen yara yeri enfeksiyonu risk faktörlerinin büyük bir kısmı modifiye edilebilir özelliktedir. Bu nedenle hastalar postpartum gelişebilecek enfeksiyon ve risk faktörleri konusunda gebelik takipleri süresince bilgilendirilmeli, bu risk faktörleri mümkün olduğunca ortadan kaldırılmalıdır.

Anahtar kelimeler: Sezaryen, Risk faktörleri, Yara yeri enfeksiyonu

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Introduction

Cesarean section (CS), the incidence of which reaches nearly one-third of all births worldwide, is one of the most common surgical procedures [1]. Although it is obvious that CS provides improvements in maternal and fetal outcomes, it could be associated with surgical site infection (SSI). The SSI after CS complicates approximately 3-15% of the deliveries, depending on the definition of infection, antibiotic prophylaxis protocol and sociodemographic characteristics of the study population [2]. Another challenging issue for detecting the incidence is the under-reported data according to the short hospital stay and inadequate surveillance system after discharge [3]. SSI can result in prolonged hospital stay, readmission, reoperation, increased health care costs and impairments in physiosocial status [4]. The three SSI classifications according to the US Centers for Disease Control and Prevention include superficial, deep and organ or space infection [5]. Each category has specific criteria, while the diagnosis of all is based on clinical data. It presents with erythema, induration and purulent or serous discharge, and usually develops in the first week after CS [6,7].

The SSI after CS can be affected by patient and health care providers characteristics and perioperative conditions [8]. Many risk factors have been claimed for SSI after CS, which include obesity, diabetes mellitus, hypertension, multiple pregnancies, tobacco use, previous CS, labor induction, presence of chorioamnionitis, large incision, long operation time, steroid use, thick subcutaneous tissue, emergent cesarean delivery and inadequate or inappropriate antibiotic prophylaxis [1,7]. Prophylactic antibiotic use, tight control of blood glucose and blood pressures, preoperative skin preparation, hair removal with clippers, vaginal cleaning, tractional placental removal instead of manual removal and subcutaneous suturing in patients with subcutaneous tissue >3 centimeter are suggested strategies for preventing SSI after CS [3,7].

To the best of our knowledge, there is only a few data in the literature about the risk factors of SSI after CS in Turkish population. In this study, we aimed to determine those risk factors and provide data to be used to develop preventive protocols in our population.

Materials and methods

This retrospective case-control study was conducted in a high-volume university-affiliated research and training hospital between June 2016 and December 2017. Approval was obtained from the Ethics Committee of University of Health Sciences, Bursa Yuksek Ihtisas Research and Training Hospital with the decision number 2011-KAEK-25 2020/10-13.

We included 76 patients between 16-45 years of age who underwent CS in our hospital and were re-admitted within 6 weeks of CS for SSI and 149 age-matched women who underwent CS in our hospital without any signs of infection during their follow-up.

Power analysis was performed to determine the required number of patients in the study group, which was a minimum of 73 individuals for each group for 85% power.

Patients whose data were unavailable during postoperative 6 weeks, those aged <16 and >45 years, who underwent concomitant surgical procedures with CS and patients who were followed-up without hospitalization were excluded.

Maternal age, gravidity, parity, height, weight, laboratory parameters such as fasting glucose, hemoglobin and hematocrit levels, hospital stay, presence of gestational diabetes (GDM), pre-pregnancy diabetes, hypertensive disorders of pregnancy, tobacco use status, operation time, indication for CS, labor induction, steroid use, postpartum hemorrhage, blood loss, history of chorioamnionitis and the number of prior CS were recorded from medical files. Body mass index (BMI) was calculated by dividing the weight by the square of height.

In our clinic, uteruses were routinely repaired with single layer and continuous technique, subcutaneous suturing was performed in patients with a subcutaneous tissue thickness>3 cm, preventive antibiotic prophylaxis were routinely administered intravenously as 3 g of cephazolin: 2 g before cesarean section, and 1 g at the 12^{th} postoperative hour.

SSI was defined as infections which occurred within one month of surgery with no implants, and within the first year in the presence of an implant. Superficial SSI was defined as the infections limited to the skin and subcutaneous tissue accompanied by at least one of the following: 1) Purulent drainage from the superficial incision, 2) Diagnosis of superficial infection by the physician, 3) Presence of signs or symptoms such as pain, tenderness, swelling or heat, if the culture was negative, and 4) Positive culture obtained from superficial incision. Deep SSI was defined as the infections involving deep soft tissue such as the fascia and muscles with at least one of the following: 1) Purulent drainage originating from the deep incision but not from the organ/space area, 2) Deep incision which spontaneously dehisced or was opened by a surgeon in patients with fever and pain, 3) Infection in the deep incisional area detected by direct examination, during reoperation or radiologic imagining, 4) Diagnosis of deep incisional SSI made by the physician [9].

For patients who were hospitalized for SSI, cultures were routinely obtained and gentamicin along with ceftriaxone were administered in the absence of any contraindications. Culture positive and clinically unrecovered patients were consulted with infection diseases. In wound hematomas, we evacuated the clot under sterile conditions, ligated or cauterized the bleeding vessels and reclosed the wound. For seromas, evacuation by needle aspiration and compressive dressing were performed. Superficial infections such as cellulitis were treated with antibiotics instead of incision and drainage. In case of purulent drainage and dehiscence, incision and drainage were performed. In the presence of necrotic tissue, we debrided the necrotic tissue to provide healthy tissue for wound healing. Once necrotic tissue was completely removed, wet dressing was placed. In fascial dehiscence, we chose urgent surgical intervention.

A diagnosis of GDM was confirmed if one or more of these were present in 75 g oral glucose tolerance test (OGTT): Fasting glucose ≥92 mg/dl, ≥180 mg/dl at 1 hour, ≥153 mg/dl at 2 hours. In two step testing, patients underwent 100-gram OGTT if 50-gram OGTT glucose levels were ≥140 mg/dl. In 100-gram OGTT, GDM was established if two or more of the following were present: Fasting blood levels ≥95 mg/dl, ≥180 mg/dl at 1

hour, ≥155 mg/dl at 2 hours and ≥140 mg/dl at 3 hours. Hypertension was defined as the systolic pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg before pregnancy or at any time of gestation. Chorioamnionitis was considered as maternal fever accompanied by at least one of the following: Maternal heart rate >100 beats per minutes, fetal heart rate >160 beats per minute and abdominal tenderness. Cesarean section operations which were performed for acute fetal distress, arrest of labor and severe hypertensive disorders, were categorized as emergent cesarean section. Postpartum hemorrhage was defined as blood loss greater than 1000 milliliters after CS or hemorrhage that impaired the hemodynamic stability of patients.

Statistical analysis

All statistical analyses were carried out with SPSS 21.0 (Stastical Package for Social Sciences). Kolmogorov Smirnov test was performed to evaluate whether the variables were distributed normally. Data were expressed as mean (standard deviation), median (minimum-maximum) and percentage. Student t test was used to compare normally distributed continuous variables between two groups while Mann Whitney U test was used for non-normally distributed continuous ones. Chi-square test was performed for categorical variables. The estimated risks of variables for SSI were determined by logistic regression analysis. An α value ≤0.05 was considered statistically significant.

Results

A total of 17380 deliveries were performed during the study period. The rate of patients who underwent CS was 43% (7590 patients) in the study group while the remaining gave birth with spontaneous or intervened vaginal delivery. The incidence of SSI, which required hospitalization for treatment was 1% (76/7590) in our study.

Superficial SSI was detected in 69 (90.8%) patients. C-reactive protein levels of SSI group were 24.8- 476 mg/dl (min-max). Intravenous antibiotherapy was administered in all patients whereas secondary suturing was used in 23 patients (30.3%) and debridement was performed in 52 patients (68.4%). Culture was positive in 12 patients (15.8%).

Baseline demographic, laboratory, and obstetric features of SSI (n=76) and control (n=149) groups are presented in Table 1. Maternal age, gravida, parity, GDM, pregestational diabetes, hypertensive disorders, cigarette use, drain placement, anesthesia method (general or spinal), urgent CS, steroid usage, meconium-stained amniotic fluid, and presence of chorioamnionitis were similar between two groups (P>0.05). BMI was higher in the SSI group compared to controls (P<0.001) while preoperative hemoglobin and hematocrit levels were lower in the SSI group (P<0.001). The SSI group had longer surgery time and higher fasting glucose levels than the control group (P=0.005 and P=0.021 respectively).

Estimated risks of SSI associated with risk factors were calculated by logistic regression analysis and are demonstrated in Table 2. Compared with the control group, patients with high BMI had 1.4-fold increased risk of SSI (OR 1.463; 95% CI 1.273-1.681, P<0.001). Likewise, patients with high fasting blood glucose levels had 1.2 increased risk of SSI (OR 1.21; 95% CI 1.06-1.37, P=0.007). Patients with high hemoglobin levels and short surgery time had a decreased risk of SSI (OR 0.532; 95% CI 0.408-0.695, P<0.001 and OR 0.947; 95%CI 0.909-0.987, P=0.010).

Table 1: Features of patient and control group

	Surgical Site Infection Group (n=76)	Control Group (n=149)	*P*-value
Age (years)	28.21(6.77)	27.76(5.79)	0.607
Gravida (n)	3(1-6)	3(1-5)	0.225
Parity (n)	2 (1-5)	2 (1-4)	0.522
Body mass index (kg/m²)	35.84(2.66)	33.62(2.76)	<0.001
Tobacco use (n,%)	4 (5.3%)	6 (4%)	0.670
Gestational diabetes (n,%)	6 (7.9%)	12 (8.1%)	0.967
Diabetes mellitus (n,%)	9 (11.8%)	8 (5.4%)	0.082
Hypertension (n, %)	7 (9.2%)	13 (8.7%)	0.904
Hemoglobin (mg/dl)	10.43(1.45)	11.42(1.23)	<0.001
Hematocrit (%)	31.52(4.08)	34.19(3.55)	<0.001
Fasting blood glucose (mg/dl)	95.40(29.74)	86.67(18.67)	0.021
Steroid use (n,%)	8 (10.5%)	15 (10.1%)	0.914
Emergent caesarean section (n,%)	20 (26.3%)	30 (20.1%)	0.291
General Anesthesia (n,%)	16 (21.1%)	30 (20.1%)	0.872
Operation time (minute)	46.14(8.96)	42.56(8.69	0.005
Drain placement (n,%)	4 (5.3%)	7 (4.7%)	0.852
Meconium stained amniotic fluid (n,%)	6 (7.9%)	12 (8.1%)	0.967
Presence of chorioamnionitis (n,%)	8 (10.5%)	16 (10.7%)	0.961

Table 2: Logistic regression analysis to predict risk factors for surgical site infection

	P-value	Odds ratio	95% CI for EXP(B)	
			Lower	Upper
Body mass index	<0.001	1.463	1.273	1.681
Preoperative hemoglobin	<0.001	0.532	0.408	0.695
Operation time	0.010	0.749	0.709	0.789
Fasting blood glucose	0.007	1.21	1.16	1.37
Age	0.396	1.025	0.968	1.087

Discussion

In this study, BMI and blood glucose levels were higher in the SSI group, while preoperative hemoglobin levels were lower and the operation times, longer. Increased levels of hemoglobin and shorter operation times were preventive for SSI.

The CS rates have been increasing continuously in our country and all over the world. Consequently, the incidence of SSI following CS is gradually increasing. CS constitutes 32% of all births in United States of America and the 2-7% of all cesarean sections were complicated with SSI [7]. Similarly, Haidar et al. [2] reported the incidence of SSI following CS as 6.5%. In the study of Johnston et al. [8], SSI following CS was 16.5%. The data from our country about CS-related SSI is quite limited. In the present study, the frequency of SSI requiring hospitalization was 1%, which is less than the literature. This may be owing to the inclusion of patients hospitalized with diagnosis of SSI only. The frequency of SSI was reported as high as 16.5% by Johnston et al., which may be due to including patients with diabetes mellitus or GDM or patients without good glycemic control in their study.

Many risk factors have been defined for SSI, one of which is increased BMI. Obesity was shown to increase the risk of surgical site complications such as seroma, hematoma, and dehiscence by at least 2-3 times [10-12]. Dotters-Katz et al. [13] reported BMI as a risk factor for SSI in patients with chorioamnionitis who underwent CS. Kawakita et al. [7] stated that SSI following CS was increased 2-2.8 times when BMI exceeded 30 kg/m² and 3.7 times when BMI exceeded 35 kg/m². Likewise, we found that increased BMI was a risk factor for development of SSI; it increased the risk of SSI 1.4 times. This direct relationship between BMI and SSI can be explained through increased thickness of subcutaneous fatty tissue or longer operation times.

According to our findings, high fasting blood glucose level is another risk factor for SSI. Hyperglycemia, known to be

associated with disturbed angiogenesis, leads to impairment in wound healing. The interaction of glucose with several growth factors may be responsible for increased risk of SSI [8]. Diabetes has been a widely accepted risk factor for SSI in past decades. Takoudes et al. [14] reported diabetes as a risk factor for SSI. Chaim et al. claimed that GDM, probably causing impairment in surgical site recovery, increased the risk of SSI [15]. In patients who underwent cardiothoracic surgery, both diabetes and postoperative hyperglycemia were associated with 2-2.5 times increased risk of SSI [16]. In the study evaluating the relationship between postpartum glycemic control and SSI, mean blood glucose levels were higher in the SSI group. On the other hand, in the same study, they could not definitely show its association with SSI and finally reported that instantaneous increases in blood glucose levels were not predictive for SSI [8]. When patients with and without postoperative SSI following CS were compared, neither the frequency of diabetes mellitus nor GDM were significantly different from each other in another study [13]. In their study including 3696 patients with SSI, Haidar et al. [2] did not determine an increased frequency of diabetes mellitus or GDM. Similarly, in the present study, the frequency of diabetes mellitus and GDM were not different between two groups. This may be due to the close monitorization of patients with diabetes mellitus and GDM, which results in better glycemic control. We found that fasting blood glucose level was a risk factor, which is an unmodifiable instant finding.

Excessive blood loss or chronic preoperative anemia can be sorted as other factors affecting postoperative surgical site recovery. In the literature, it is claimed that in case of low hemoglobin levels, the oxygenation of surgical site is decreased, and the macrophage activity is disturbed [17]. In a study of Guzman et al., every 100 ml blood loss was found to increase the risk of SSI by 1.3 times [18]. In another study, in patients who had blood loss requiring postpartum transfusion, the incidence of SSI was significantly higher [2]. Wodajo et al. [19] showed that when hemoglobin levels were lower than 11 mg/dl, the risk of SSI increased 2.6 times. On the other hand, Chaim et al. investigated the incidence of postpartum anemia among patients who developed postpartum endometritis and SSI and observed that postpartum anemia was more common in the endometritis group, and not significantly higher in the SSI group [15]. In our study, we found that hemoglobin levels were lower in the SSI group and higher hemoglobin levels were protective against SSI.

One of the risk factors we determined in this study was operation time. In patients who developed SSI, we observed that operation time was significantly longer compared to control group. In previous studies, when the operation time for CS exceeded 38 minutes, the risk of SSI increased [20]. In the study by Wodajo et al. [19], in operations lasting longer than 1 hour, SSI was observed 12 times more commonly. In another study from Nigeria, the rates of SSI in the longer and shorter operative time groups were 55% and 31.7%, respectively [21]. The results of researches conducted in Tanzania and China supported the presence of a correlation between operation times and SSI [22-24]. The underlying mechanism of this correlation may be explained as the increased contamination of surgical site by microorganisms with longer operation time.

Limitations

Our study has several limitations. First, this is a retrospective study with small sample size. Second, patients who were diagnosed with SSI and treated in clinics other than our hospital were not included in this study. Third, we only included patients who were hospitalized for SSI. Lastly, many factors such as the surgeon, single- or two-layer closure of Kerr incision, thickness of subcutaneous tissue, application of subcutaneous suture, type of incision, whether the surgical site is washed or not and the type of skin suturing, all of which are risk factors for SSI in the literature, were not evaluated due to the retrospective design of the current study.

One strength of this study is that this is a single center study providing the opportunity of minimizing the differences in surgical and postoperative care procedures.

There are a plenty of risk factors for SSI, most of which are modifiable. For that reason, patients should be informed about the possibility of postpartum SSI and associated modifiable risk factors.

Conclusion

Optimum weight gain should be offered according to BMI and if required, patients should be referred to dietitians for professional support. Particularly if high fasting blood glucose levels are determined in the first antenatal visit, close monitorization of blood glucose level should be performed and endocrinologic consultation should be considered if it persists. Prepartum anemia should be diagnosed and treated promptly with appropriate iron supplementation either by oral or parenteral route. Lastly, surgical procedure should be performed under maximum sterile conditions and operation time should be optimum.

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