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ORIGINAL ARTICLE

Evaluation of Risk Factors of Surgical Site Infections After a Lower Segment Cesarean Section in Bahrain - A Retrospective Analytical Study

Hasan Almajed[1]*, Yusuf Jalili[2], Ahmad Noor[3], Mahmood Alawainati[4]

[1]Department of Obstetrics and Gynecology, Salmaniya Medical Complex, Manama, Bahrain

[2]Medical student, Diyar Almuharraq, Bahrain

[3]Medical student, Busaiteen, Bahrain

[4]Primary Healthcare Centers, Manama, Bahrain

***Corresponding author:**

Dr Hasan Almajed. Salmaniya Medical Complex, Manama, Bahrain; E-Mail: hnmajed@gmail.com

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Abstract

Background: Surgical Site Infections (SSI) impose a critical complication following lower segment cesarean sections (LSCS), contributing significantly to maternal morbidity and mortality. Understanding the risk factors associated with SSI is essential for improving clinical outcomes and enhancing patient care. This study aimed to identify the rate and risk factors associated with SSI among women who underwent LSCS at Salmaniya Medical Complex (SMC) in Bahrain.

Methods: A retrospective observational study was conducted at SMC in the period between 2020 and 2023. All patients with SSI post-LSCS and a comparable sample of patients who underwent LSCS but had no SSI were included. Data including patient demographics, clinical characteristics, and specific risk factors related to SSI were collected from electronic medical records. Descriptive and inferential analyses were done.

Results: The rate of SSI was 2.1% among women who underwent LSCS in SMC. Predictors of higher rates of SSI post-LSCS included having an emergency LSCS (odds ratio [OR]=4.14), a longer hospital stay (OR 1.37), and pre-operative stage 1 hypertension (OR=2.66), while diabetes mellitus (OR=0.29) and post-operative elevated laying blood pressure were linked to a reduced risk (OR=0.42) of post-LSCS SSI.

Conclusion: This study revealed a low rate of post-LSCS SSI. This study highlighted the implications of emergency procedures, hospital stay duration, and blood pressure management. The paradoxical protective effect of diabetes mellitus warrants further investigation. These insights are pivotal for developing targeted interventions aimed at minimizing SSI, thereby enhancing maternal health outcomes in clinical practice.

Keywords: Pregnancy, Female, Surgical Wound Infection, Cesarean Section, Risk Factors

Introduction

The rates of lower-segment cesarean sections (LSCS) have been increasing in the last decades aiming to improve maternal and fetal outcomes.[1] According to the World Health Organization (WHO), LSCS constitutes as high as 15% of all deliveries worldwide.[2] This rise in LSCS rates comes with risks including postpartum bleeding, anesthesia-related complications, and infections.

Literature has shown that LSCS increases the risk of maternal infections by five to twenty times when compared to vaginal delivery. Surgical site infections (SSI) and urinary tract infections (UTI) are the main healthcare-associated infections.1 An SSI is an infection involving the abdominal incision or deep tissue within 30 days after surgery.[3] Every year, SSIs endanger millions of patients' lives and contribute to the development of antibiotic resistance. More than 10% of patients undergoing lower segment cesarean section (LSCS) in low- and middle-income countries develop SSI.[4] Globally, the estimated rate of LSCS-related SSI is around 6%.[5]

Post-LSCS SSI can lead to a considerable negative impact on maternal and neonatal outcomes leading to delayed recovery, increased length of hospital stays, and higher morbidity and mortality.[6] Even with the availability of antibiotics, managing SSI remains challenging in some cases.[7] Therefore, many guidelines recommend a comprehensive evaluation of patients undergoing LSCS is essential to mitigate SSI risks. This evaluation should aim to identify areas that can be amended before, during, and after LSCS to lower the risk of occurrence of SSI.[8-9] Coordinated efforts aimed at reducing the risks of SSIs were shown to be effective.[9]

One step to avoid SSI among patients undergoing LSCS is to identify patients at higher risk of LSCS. Many studies were conducted to identify the risk factors of SSI. According to the literature, several risk factors have been associated with post-LSCS SSI. These include obesity, diabetes mellitus, prolonged labor, prolonged rupture of membranes, multiple vaginal examinations, emergency cesarean section, excessive blood loss, and prolonged operative time.[12-15] A systematic review also identified factors such as chorioamnionitis, previous cesarean delivery, lack of antibiotic prophylaxis, and lower socioeconomic status as significant risk factors.[16] Additionally, tobacco use, hypertension, and corticosteroid use were found to be associated with increased SSI risk following cesarean delivery.[17]

Although many studies were done to identify the risk factors of post-LSCS infection, no previous studies were conducted to assess this topic in Bahrain. To close this gap, this study aimed to identify the risk factors associated with the occurrence of SSI among females who underwent an LSCS at Salmaniya Medical Complex (SMC), Bahrain.

Method

Design and setting

A retrospective analytical study was conducted at the Obstetrics and Gynecology Department at Salmaniya Medical Complex (SMC). SMC is a tertiary center that provides medical services to citizens and residents in Bahrain.

Selection criteria

Patients who underwent either emergency or elective LSCS in the period between 2022-2023 were eligible for inclusion.

Sample size

Based on a total number of LSCS of 8011, assumed 10.3% of cases were diagnosed with post-LSCS wound infections, an acceptable estimate of 5%, a design effect of 1 and a confidence interval (CI) of 95%, the total sample size that was considered in this study was 343 pateints.

Sampling process

In the period between 2020-2023, a total of 8011 females underwent LSCS at SMC. All females who got SSI were recruited in the study, while a comparable sample was taken from those who did not have SSI post-LSCS. The data was collected during the period between March and April of 2024.

Diagnosis of cellulitis and bloody discharges, stitch abscess alone (minimal inflammation and discharge confined to the points of suture penetration), patients presented after 30 days of surgery were not included in the cases group. Patients were considered as SSI based on criteria set by the CDC.[11] The patient presentation must be within 30 days of surgery AND have at least one of the following:

a. purulent drainage from the superficial incision.

b. organism(s) identified from an aseptically obtained specimen from tissue by a culture or nonculture-based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment.

c. a superficial incision that is deliberately opened by a surgeon, physician, or physician designee and patient must have at least one of the following signs or symptoms: localized pain or tenderness; localized swelling; erythema; or heat.

Another 172 females who did not develop SSI were selected to serve as controls. Females that were proven to be free from SSI and were operated on during the selected period and had complete medical records were considered controls, however only 172 consecutive females were chosen until attaining the required sample (Figure 1).

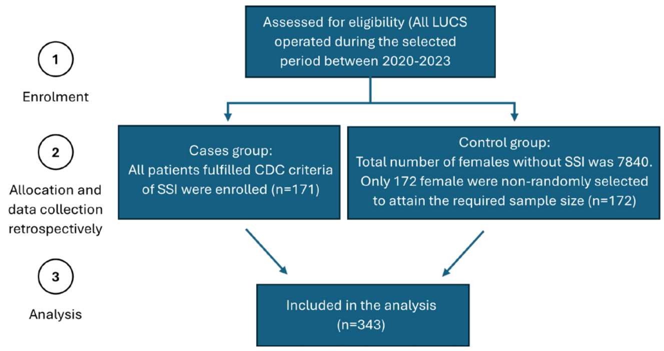

Figure 1: Flow chart of study

Data collection process

Patients' names who underwent LSCS were collected from the registry logbook of the hospital in all the surgical wards, and then the electronic medical records (iSeha) were used to collect the relevant data. The data was coded and anonymized.

Ethical consideration

The protocol of the present research was approved by the Research and Research Ethics Committee at SMC number 80090723. Since there was no direct contact with cases, no informed consent was considered for the study.

Data management

Numerical data were presented as median and Interquartile range (IQR), while categorical data were described using frequencies and percentages. As appropriate, the chi-square test, fisher exact test, and Mann-Whitney test were performed. All statistical calculations were done using SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 27 and Prism Graph Pad. For all analyses, a P value of less than 0.05 was considered statistically significant.

Results

Out of a total of 8301 LSCS surgeries, 171 cases had SSI constituting an incidence of 2.1% (Figure 2).

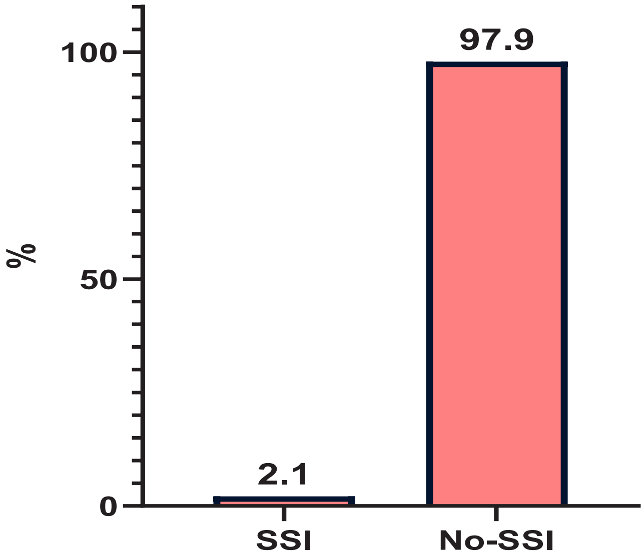

Figure 2: Incidence of SSI Among Females Who Underwent LSCS

Table 1 presents the association between patient characteristics and risk of SSI. A significant association was found between diabetes mellitus and post-LSCS SSI ($p<0.001$). Patients who underwent emergency LSCS had a higher rate of post-LSCS SSI compared to their counterparts ($p<0.001$). In addition, a significant association was found between hospital stay length and SSI post-LSCS ($p=0.005$). Pre and post-operative blood pressure was also significantly different between both groups ($p<0.05$).

Table 1: Characteristics of Patients Undergoing LSCS and The Risk of SSI

Parameters	Total Participants		P value
	Presence of SSI no=171	Absence of SSI no=172	
Age, median (IQR)	31.0 (27.0-35.0)	31.0 (27.0-36.0)	**0.662⸸**
Nationality, no (%)			
GCC	117 (68.4)	125 (72.7)	**0.388⸸⸸**
Non-GCC	54 (31.6)	47 (27.3)	
BMI, no (%)			
Underweight	1 (0.6)	1 (0.6)	0.754⸸⸸⸸
Normal	29 (17.0)	32 (18.6)	
Overweight	41 (24.0)	49 (28.5)	
Obese	100 (58.5)	90 (52.3)	
DM, no (%)	20 (11.7)	47 (27.3)	<0.001*⸸⸸
Smoking, no (%)	10 (5.8)	6 (3.5)	0.300⸸⸸
Alcohol intake, no (%)	0 (0.0)	0 (0.0)	
Gravida, no (%)			
1	60 (35.1)	60 (34.9)	0.365⸸⸸
2-3	91 (53.2)	83 (48.3)	
>3	20 (11.7)	29 (16.9)	
Type of pregnancy, no (%)			
Singleton	159 (93.0)	153 (90.0)	0.324⸸⸸
Twins	12 (7.0)	17 (10.0)	
Type of LSCS, no (%)			
Elective	27 (15.8)	68 (39.5)	<0.001*⸸⸸
Emergency	144 (84.2)	104 (60.5)	
PROM, no (%)	6 (3.5)	9 (5.2)	0.435⸸⸸
Fetal distress, no (%)	49 (28.7)	44 (25.6)	0.522⸸⸸
Blood loss/ 100 ml, median (IQR)	4.0 (4.0-6.0)	4.0 (3.0-5.0)	0.001*⸸
Hospital stay, median (IQR)	3.0 (3.0-4.0)	3.0 (3.0-3.0)	0.005*⸸
Pre-operative sitting blood pressure, no (%)			
Low	12 (7.0)	19 (11.0)	0.012*⸸⸸
Normal	70 (40.9)	90 (52.3)	
Elevated	36 (21.1)	35 (20.3)	
Stage 1	31 (18.1)	13 (7.6)	
Stage 2	22 (12.9)	15 (8.7)	
Post-operative laying blood pressure, no (%)			
Low	10 (5.8)	1 (0.6)	0.006*⸸⸸
Normal	103 (60.2)	98 (57.0)	
Elevated	27 (15.8)	46 (26.7)	
Stage 1	18 (10.5)	20 (11.6)	
Stage 2	13 (7.6)	7 (4.1)	

IQR=Interquartile range (25th -75th percentile), LSCS= Lower Segment Caesarean Section, SSI=Surgical site infection, GCC=Gulf cooperation council nationality, ⸸Mann-Whitney U test, Chi-square test, ⸸⸸⸸Fisher exact test, *Indicates significant p-value at 0.05

Table 2 shows the logistic regression analysis of risk factors of SSI among women who underwent LSCS. The presence of diabetes mellitus was significantly protective against the occurrence of SSI (OR=0.29, 95% CI=0.15-0.58; P<0.001). Also, emergency LSCS was associated with a 4.82 times higher risk of occurrence of SSI compared to the elective LSCS (OR=414, 95% CI=2.17-7.9; P<0.001). A one-day increase in hospital stay was associated with a 37% increase in the likelihood of SSI (OR=1.37, 95% CI=1.11-1.7; P=0.003). In addition to that, having stage 1 pre-operative sitting blood pressure was associated with increased risk for SSI (OR=2.66, 95% CI=1.16-6.12; P=0.021), while having post-operative elevated laying blood pressure was associated with decreased risk for SSI (OR=0.42, 95% CI=0.22-0.8; P=0.009).

Table 2: Logistic Regression Analysis of Risk Factors of SSI Among Women Who Underwent LSCS

Parameters	OR	95% CI		P value
		Lower bound	Upper bound	
Age	1.0	0.95	1.05	**0.896**
Nationality				
Non-GCC	RF			
GCC	0.87	0.49	1.53	**0.625**
BMI				
Normal	RF			
Underweight	1.02	0.05	22.32	0.988
Overweight	0.77	0.35	1.69	0.522
Obese	1.15	0.58	2.28	0.695
DM	0.29	0.15	0.58	<0.001*
Smoking	2.51	0.74	8.5	0.138
Gravida				
1	RF			
2-3	1.17	0.65	2.1	0.596
>3	0.79	0.33	1.91	0.600
Type of pregnancy				
Elective	RF			
Emergency	4.14	2.17	7.9	<0.001*
PROM	0.38	0.11	1.26	0.112
Fetal distress	0.67	0.36	1.23	0.195
Blood loss/ 100 ml	1.14	0.99	1.3	0.074
Hospital-stay	1.37	1.11	1.7	0.003*
Pre-operative sitting blood pressure				
Normal	RF			
Low	0.57	0.23	1.43	0.229
Elevated	1.2	0.62	2.31	0.594
Stage 1	2.66	1.16	6.12	0.021*
Stage 2	2.22	0.94	5.25	0.068
Post-operative laying blood pressure				
Normal	RF			
Low	7.21	0.82	63.53	0.075
Elevated	0.42	0.22	0.8	0.009*
Stage 1	0.6	0.27	1.36	0.221
Stage 2	0.92	0.28	3.03	0.892

OR=Odds ratio, CI=Confidence interval, RF=Reference category, *Indicates significant p-value at 0.05

Discussion

This study aimed to determine the prevalence and risk factors of post-LSCS SSI among patients in SMC. The study revealed an SSI rate of 2.13% with a higher risk among patients who had longer hospital stays and had emergency LSCS. This rate of SSI post-LSCS is consistent with global findings that report SSI rates post-cesarean delivery ranging from 5% to 20%.[18] The reported rate of SSI in this study is lower than that reported by Gupta et al. (10.3%) but comparable to the rate reported by Ketcheson et al (2.7%).[1,6] The variation in the rates of SSI in the post-LSCS period can be attributed to different preventive measures, patients' characteristics, and research methods.

The data of this study revealed that emergency LSCS was significantly associated with a 4.14-fold increase in the risk of SSI compared to elective procedures. This aligns with the existing literature that consistently shows higher rates of SSI in emergency surgeries. Possible reasons for this finding include higher contamination risk, suboptimal patient preparation, and often poorer patient health status at the time of surgery.[7] Contrary to our study, Gupta et al. found no association between the type of LSCS and the risk of SSI.[1] The high proportion of emergency surgeries (84.2% in SSI cases) underscores the need for enhanced preoperative optimization and risk stratification protocols for patients undergoing emergency cesarean sections.

Our findings indicated that each additional day of hospital stay was associated with a 37% increase in the likelihood of developing SSI. This correlation suggests that prolonged hospitalization may expose patients to additional risks of nosocomial infections. This observation resonates with the work of Zimlichman et al. who highlighted that longer hospital stays increase exposure to pathogens and complicate recovery.[21] Interestingly, our study identified that elevated pre-operative sitting blood pressure was associated with increased SSI risk (OR=2.66, 95% CI=1.16-6.12; P=0.021), whereas elevated post-operative laying blood pressure was linked to a decreased risk of SSI (OR=0.42, 95% CI=0.22-0.8; P=0.009). These findings suggest a complex relationship between hemodynamic status and infection risk, indicating that hypertension may compromise immune response or contribute to vascular complications that predispose patients to infection.[22] Further research is warranted to elucidate these relationships.

One of the most surprising findings of our study was the significant association between diabetes mellitus and the incidence of SSI. Contrary to expectations that diabetes would heighten the risk of infection, our results indicated that the presence of DM was significantly protective against SSI. This finding is paradoxical and may warrant further investigation into the role of preoperative blood glucose management and perioperative care in diabetic patients. Previous studies have shown that diabetes has increased the risk of SSI.19 Also, a systematic review that recruited eight studies to investigate the relationship between glycemic control strategies performed and the occurrence of surgical site infection in adult patients undergoing surgery, concluded that proper glycemic control gave satisfactory results in preventing the occurrence of SSI.20 This finding suggests that careful metabolic control preoperatively could be a critical factor in reducing SSI rates.

This study recommends adopting strategies to minimize hospital stays, improve the care of patients undergoing emergency LSCS, and apply strict preventive measures in these patients.

This study carries inherent limitations, including its retrospective design, which may introduce selection bias. Furthermore, the single-center nature of the study limits the generalizability of findings to broader populations. Further prospective studies to determine the influence of diabetes on SSI among women who underwent LSCS are needed.

Conclusion

In summary, this study revealed a low rate of SSI among women who underwent LSCS in SMC in Bahrain. Patients who had emergency surgery and who were admitted for longer duration were at a higher risk of SSI compared to their counterparts. Surprisingly, patients with diabetes were found to have lower risks of SSI post-LSCS. Further studies to determine the effective measures to mitigate the risks of SSI among patients undergoing LSCS are needed.

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Conflict of interest

The authors declared no conflict of interest.

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