

ORIGINAL PAPER

doi: 10.5455/medarch.2021.75.138-143

MED ARCH. 2021 APR; 75(2): 138-143

RECEIVED: MAR 23, 2021

ACCEPTED: APR 25, 2021

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Wound Infection Incidence and Obesity in Elective Cesarean Sections in Jordan

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ABSTRACT

Background: Wound infection is a challenge that face healthcare facilities. **Objective:** The aim of the study was to assess the effect of obesity on wound infection incidence. **Methods:** A prospective study involved 127 patients underwent elective Cesarean section surgeries in the first ten months of 2018 with a follow up period of 90 days. **Results:** The wound infection incidence was 37.8%; the suture infection was 15.7% and SSI was 22%, which divided into: the superficial SSI among 23 (82.1%) patients, and deep tissue SSI among five (17.9%) patients. Obese patients with BMI of 30 kg/m² or more were significantly at higher risk for wound infections than those whose BMI less than 30 kg/m² (p= 0.02, relative risk= 2.363). **Conclusion:** Obese patients who underwent Cesarean sections were found to have higher risk to develop wound infections. A larger scale study is needed to determine other associated risk factors.

Key words: surgical site infection, suture infection, obesity, incidence.

1. BACKGROUND

Nosocomial infections, which involve wound infection, are preventable infections that patients acquire while receiving medical treatment during hospitalization period and are considered a major threat to patients' safety (1). Wound infection post any surgical procedure involves both SSI and suture infection because of sutures' direct contact with surgical wounds. Even with negative cultures in infected wounds; bacilli and cocci, especially staphylococci, were found on the surface of sutures. Thus, external sutures act as foreign bodies that can be a source of infection and cause SSI (2). The Centers for Disease Control and Prevention (CDC) in their definition of SSI for surveillance and diagnosis, updated in January 2019, did not consider suture infection as superficial surgical site infection (SSI) (3). The CDC defined suture infection as "minimal inflammation and discharge confined to the points of suture penetration", whereas SSI was defined as "An infection that happens within 30 or 90 days after a surgery if there is no implant or one year after implant". Classification of SSI's within the definition of SSI for surveillance and diagnosis were: Superficial incisional infection, that involves only skin and subcutaneous tissue of the incision and occurs within 30 days after an operation, deep tissue infection that involves deep soft tissues of the incision and organ or space infection involving any part of the body deeper than the fascial/muscle layers, that is opened or manipulated during the operative procedure. Both of deep tissue infection and organ or space infection can occur within 30 or 90 days after the operation (3).

According to the English National Prevalence Survey, the prevalence for nosocomial infections was 6.4% and SSI was found to be the third most common infection (5.7%) (4). In a more recent survey that included 183 acute care hospitals, SSI was the second nosocomial infection after pneumonia with a rate of 21.8% from all infections (5). Furthermore, the World Health Organization (WHO) reported that patients in surgical wards who develop SSI have complicated hospitalization at a cost of up to US\$ 10 billion per year, which adds on the burden of care (6).

The SSI rate in high-income countries was found to be around 5.0% (7). Similarly, Jenks and colleagues (8) found in their two years prospective study in England that the rate of SSI was around 5.1%. In India, which is considered moderate-income country, the rate of SSI was 7.84% (9). According to

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WHO, 11% of patients who underwent surgical procedures in low and middle-income countries such as Jordan had SSI (10). In Jordan, a study concluded that the overall nosocomial infections rate was 17.2% in one educational hospital (11). In another non-randomized study case-control trial concluded that SSI rate among patients who underwent abdominal surgeries in Jordan was 25% which is markedly high (12). For Cesarean section (C-section) only surgeries, a study was conducted at another educational hospital and reported an SSI rate of 14.4% after one month follow up (13). If we compare the previous reported rate in Jordan with India where the rate for obstetric and gynecological SSI was 7.84% (9), or with SSI rate in China where SSI rate was 5.7% for the same type of operations (7) and with the SSI rate reported in English hospitals which was 7.6% for C-sections (8), we notice that Jordan has a higher rate of SSI for similar gynecological operations.

Regarding the types of SSI, Jenks and colleagues (8) concluded that 65.2% of SSI cases were superficial infections within the admitted and re-admitted surgical patients, while 34.8% of them were for both the deep and organ or space infections. Furthermore, 3.2% of surgical patients were found to have SSI post-discharge and 89.4% of them were having superficial infection. In addition, patients who developed SSI during admission were three times more likely to need readmissions more than those who did not develop SSIs.

Approximately 50% of post-operative wound infections occurs after discharge (14). For this reason, post discharge survey is needed to estimate accurate incidence (1). Inappropriate post discharge SSI surveillance can be done because sometimes surgical patients revisit other health care agencies for wound assessment and treatment rather than that one where they were operated, resulting in underestimation of the SSI incidence and its' associated costs. For this reason, the CDC recommended post discharge survey using the indirect methods, which involved emails or telephone calls (15). At the time of this study, the involved hospital was applying post discharge survey for wound infection involving SSI incidence estimation just for patients who were followed in the hospital clinics for surgical wound assessment, while those who had followed post operatively at other health care agencies were not involved. This study will estimate accurate wound infection incidence for both suture infection and SSI using post discharge survey involving all patients who underwent C-section at the involved hospital either they did their wound follow ups at the same hospital or other health care agencies.

Surgical site infection is one of the challenges that faces health care providers in both surgical wards and critical care units, and it is associated with high costs. These costs are related to the increase in hospital stay in general wards or ICUs and the risk for litigation and even repeated surgeries, which lead to a double financial burden (8, 16, 17, 18). In addition, SSI has an impact on reducing the quality of life and patient satisfaction because of the increased level of pain, distress, and delayed wound healing (19, 20). The associated risk factors

should be considered to prevent or decrease the incidence of such infections. In some clean surgeries, obese patients presented with higher SSI incidence compared with normal weight patients (16.5% versus 2.5% respectively), so obesity can be one of the risk factors for SSI (21). For this reason, our study question was: is there is a relationship among surgical wound infections and obesity among patients who underwent C-section surgeries?

2. OBJECTIVE

The aim of this study was to assess the effect of obesity on wound infection incidence.

3. MATERIALS AND METHODS

Setting and Eligibility criteria

This study was conducted within a ten-month period from the first of January until the 30th of October 2018 at one of the major hospitals in Amman, Jordan.

After the Institutional Review board approval was obtained from the involved hospital, the informed consent was obtained from all the patients. Patient's confidentiality, integrity and privacy were maintained. All patients had the right to refuse participation or withdraw at any time of the study.

This study included all patients who had an elective C-section in the same operating room, having controlled blood sugar less than 200 mg/dl before the surgery and during the first 24 hours post operatively, which was recommended by the CDC (3), patients were included if they had not been diagnosed with gestational diabetes during pregnancy and the ultrasound test at the 32 weeks of pregnancy was free of fetal macrosomia, which defined as a body birth weight greater than 90th percentile of age. Moreover, patients were included only if they were received cephalosporin injection 1g intravenously before the surgical incision as prophylactic antibiotic. At the end of the surgery, the patients were included if the method of wound closure was done using subcuticular technique with absorbable sutures and if wound dressings were done using gauze dressing and were exposed for the first time after 48 hours post operatively. Exclusion criteria included having surgical procedures at least 90 days before the current surgery, if the patients had any kind of implant within the last year and if the patients had an emergency surgery. Patients were dropped from the study if the researchers were unable to maintain contact with them for a period of 90 days post operatively.

Methods

This prospective study used post discharge survey to estimate the post-operative incidence of surgical wound infections including SSI and suture infections. The survey involved all patients wither they followed their wound at the hospital or other health care agencies. The aim was to find if there is a relationship among surgical wound infections and obesity. Sample size was estimated by using G. power 3.0 analyses (22) based on the chi-square test using moderate effect size (0.3), at power of

Categories of SSI	Criteria
1. Superficial Incisional Infection	<p>Must meet the following criteria: Infection occurs within 30 days after any operative procedure (where day 1 = the procedure date) AND involves only skin and subcutaneous tissue of the incision AND patient has at least one of the following:</p> <ul style="list-style-type: none"> a. purulent drainage from the superficial incision. b. organisms identified from an aseptically-obtained specimen from the superficial incision or subcutaneous tissue by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment c. superficial incision that is deliberately opened by a surgeon, attending physician or other designee and culture or nonculture based testing is not performed AND patient has at least one of the following signs or symptoms: pain or tenderness; localized swelling; erythema; or heat. d. diagnosis of a superficial incisional SSI by the surgeon or attending physician or another designee
2. Deep Infection	<p>Infection occurs within 30 or 90 days after the operative procedure (where day 1 = the procedure date) AND involves deep soft tissues of the incision (for example, fascial and muscle layers) AND patient has at least one of the following:</p> <ul style="list-style-type: none"> a. purulent drainage from the deep incision. b. a deep incision that spontaneously dehisces, or is deliberately opened or aspirated by a surgeon, attending physician or other designee AND organism is identified by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment or culture or non-culture based microbiologic testing method is not performed AND patient has at least one of the following signs or symptoms: fever (>38°C); localized pain or tenderness. A culture or non-culture-based test that has a negative finding does not meet this criterion. c. an abscess or other evidence of infection involving the deep incision that is detected on gross anatomical or histopathologic exam, or imaging test
3. Organ/ Space SSI	<p>Infection occurs within 30 or 90 days after the operative procedure (where day 1 = the procedure date) AND infection involves any part of the body deeper than the fascial/muscle layers, that is opened or manipulated during the operative procedure AND patient has at least one of the following:</p> <ul style="list-style-type: none"> a. purulent drainage from a drain that is placed into the organ/space (for example, closed suction drainage system, open drain, T-tube drain, CT*** guided drainage) b. organisms are identified from an aseptically-obtained fluid or tissue in the organ/space by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment. c. an abscess or other evidence of infection involving the organ/space that is detected on gross anatomical or histopathologic exam, or imaging test evidence suggestive of infection AND meets at least one criterion for a specific organ/space infection site

Table 1. CDC* Criteria for SSI. *CDC= Centers for Disease Control and prevention; **SSI= Surgical Site Infection; ***CT= Computed Tomography**

0.8, and alpha 0.05. The estimated sample size was 88 patients. However, we recruited 127 patients in our study.

Body mass index (BMI) was used as an indicator for obesity and was calculated by the division of the body weight in kilograms over the square height of the patient in meters. According to the WHO classifications (23), the patients were categorized according to BMI to be either obese with BMI equal or more than 30 kg/m² or non-obese with BMI less than 30kg/m². The researcher used the CDC definition of SSI for surveillance and diagnosis (3) to diagnose the presence of both suture infection and SSI (Table 1). All the patients, who had met the eligibility criteria, were recruited preoperatively. Then each patient was followed postoperatively for 90 days for surgical wound assessment instead of 30 days to detect any signs of infection for deep tissue and organ or space SSI in addition to superficial incisional SSI according to CDC criteria. In the first follow up month, the researcher followed the patients once weekly and then once every other week in the second and third months except in case that the patient was diagnosed with wound infections, where the patients with infected wounds were followed weekly until healing. Wound assessment post-operatively was done directly by the attending surgeon for all patients during hospitalization period and during

Patients' characteristics	Mean (SD*)	N (%)
Age	31.2 (5.22)	
BMI**:		
Less than 30 kg/m ² (non-obese)		67 (52.8)
30 kg/m ² or more (obese)		60 (47.2)
Cause of surgery:		
Previous C-Section***		89 (70.1)
Other causes		38 (29.9)

Table 2. Sample characteristics (N=127). *SD= Standard Deviation; **BMI= Body Mass Index; *C-section= Cesarean Sections**

The incidences	N (%)
Wound infection incidence:	
Patients with wound infections	48 (37.8)
Patients free of wound infections	79 (62.2)
Types of wound infections:	
Suture infections	20 (15.7)
SSI*	28 (22)
SSI developed from suture infection	9 (7)
Types of SSI: (% of infected cases n=28)	
Superficial incisional SSI	23 (82.1)
Deep tissue SSI	5 (17.9)

Table 3. Wound Infections Incidence among study sample (N=127). *SSI= Surgical Site Infections

Study variables	Non-obese patients (BMI* < 30 kg/m ²) (n=67)	Obese patients (BMI= 30 kg/m ² or more) (n=60)	Relative risk	P value
Wound infection incidence:				
Patients with wound infections	19 (28.4)	29 (48.3)	2.363	0.02
Patients free of wound infections	48 (71.6)	31 (51.7)		
SSI** incidence alone:				
Patients with SSI	12 (17.9)	16 (26.7)	1.667	0.24
Patients without SSI	55 (82.1)	44 (73.3)		

Table 4. Comparison of Wound Infections Incidence Between Study Groups (N=127). *BMI= Body Mass Index; ** SSI= Surgical Site Infections

the patient's follow up at the hospital clinics. Patients who did not come back to our hospital where they had their operation and visited other health care agencies or private clinics for wound follow up after discharge were followed by phone calls with the health care professionals who cared for them and they were asked about the presence of any signs of infection for suture infections and all types of SSI according to CDC criteria and this was documented. At the end of data collection, the data was analysed using the Statistical Package for the Social Sciences (SPSS) version 22 and chi-square test was used to find any differences in wound infection incidence between obese and non-obese patients.

4. RESULTS

A total of 146 patients agreed to participate in our study; nineteen (13%) of them were excluded because of loss of follow up post operatively. A total of 127 patients were involved and their wounds were followed for three months, which indicated a response rate of 87%. As presented in Table 2, the most common cause for C-section surgeries was having a previous C-section, which was repeated in 89 (70.1%) patients. Age ranged from 19 to 44 years with mean age of 31.2 (SD= 5.22) and a total of 67 (52.8%) were non-obese patients with a BMI less than 30 kg/m².

Out of 127 patients, a total of 48 (37.8%) patients had signs of infection in their surgical wounds either as suture infections or SSI. Suture infection was found among 20 (15.7%) patients, while a total of 28 (22%) patients complained from SSI. Among those patients who were diagnosed with SSI, a total of 9 (7%) complained from suture infections that were developed to SSI. Two types of SSI were found; the superficial SSI among 23 (82.1%) patients and deep tissue SSI among 5 (17.9%) patients (Table 3).

As shown in Table 4, patients were categorized according to their BMI into two main groups; obese group with BMI of 30kg/m² or more and this group included 60 (47.2%) patients, and a total of 67 (52.8%) patients were in the non-obese group with BMI less than 30kg/m². Surgical wound infections were found among 19 (28.4%) patients in the non-obese group, meanwhile a total of 29 (48.3%) patients in the obese group had surgical wound infections. Using chi-square test, there was significant difference between BMI categories in relation to the incidence of wound infections including both suture infection and SSI ($p = 0.02$, chi-square= 5.372).

The obese patients, whose BMI was 30kg/m² or more, were at risk for surgical wound infections 2.363 times higher than those whose BMI was less than 30kg/m². Excluding suture infection, there was no significant difference between BMI categories in relation to SSI incidence alone ($p= 0.24$).

5. DISCUSSION

The aim of this prospective study was to use post discharge survey to estimate accurate wound infection incidence including suture infections and SSI among surgical patients, who underwent elective C-section surgeries. In addition to find if there is any relationship between obesity and wound infections in the surgical wounds. Postoperatively, the patients were followed in the clinic by their surgeon, and for those patients who were followed in other healthcare facilities, the health care provider who cared for them was contacted by telephone and asked about signs of wound infections for validation, which was recommended by the CDC for post discharge survey (15). As well as, telephone calls to detect SSI after discharge were recommended by Nguhuni and colleagues during 2017, after they reported a sensitivity and specificity of 72% and 100% respectively for this way of post discharge follow up (24).

Although suture infection is not considered as superficial SSI according to the CDC criteria (3), external sutures in the wounds act as foreign bodies that can be source of infection as some microorganisms' colonization were found on their surface (2). For this reason, wound infection incidence in this study included both suture infection and SSI. A total of 48 (37.8%) patients complained from both types of wound infections; suture infection and SSI. Suture infection was recorded among 20 (15.7%) patients, while a total of 28 (22%) patients complained from SSI in their surgical wounds 9 (7%) of them their SSI developed from suture infection. The incidence of SSI is considered high if compared with SSI incidences in other studies. The variations were seen among countries and different surgical procedures. The SSI incidence in our study was 22% for C-sections, which is higher than the reported SSI incidence (7.6%) in a survey conducted in England (8), and higher than what was reported in a meta-analysis done by Fan and colleagues in China where SSI rate was 5.7% (7).

Although the SSI incidence, which was 14.4% in C-sections in a study conducted at an educational hospital in Jordan after one month follow up period was high-

er than worldwide incidence (13), our SSI incidence for the same surgery is higher (22%). Several factors can explain the high SSI incidence in our study. First of all, the three-month post discharge follow-up period instead of one month. Using of the three-month post discharge follow up period was recommended by the CDC criteria to identify the incidence of deep tissue and organ or space infections (15). Moreover, the researcher was unable to observe the practice inside the operating room which can be associated with high infection rate if it was not restricted to the policies. In addition to the patients attitudes and behaviours regarding their wound follow up post discharge; even when they had appointment for wound follow up a week after discharge, some patients depended on themselves at home or referred to public health care agencies for wound assessment instead of seeking medical services for wound follow up at the hospital, which led them to present with signs of infection that needed treatment with antibiotics and admission sometimes. Also, an absence of standardized assessment and treatment regimen for the early signs of infection among different health care providers and agencies caused a variation in wound infection assessment and treatment among healthcare providers. Regarding the type of SSI, the CDC criteria divided SSI into 3 main types, superficial incisional infection that occurs within the first 30 days post operatively, deep tissue infection and organ or space infections both of which can occur until 90 days post operatively.

In our study, most of the patients (82.1%) had superficial SSI, deep tissue infection compromised only 17.9%, while no organ or space infections were reported. These results considered better than what was reported by Jenks and colleagues (8), where 65.2% of SSI cases were superficial infections, while both the deep tissue and organ or space SSI reported a rate of 34.8%.

Limitation of the study

The researcher's authority to enter the operation room and document all healthcare providers practices was prohibited. Some participants did not return to the same hospital for wound assessment but they did it by themselves or in a public health care agency. In addition, generalization of the findings will be more relevant to similar cases of female patients under C-sections surgeries.

6. CONCLUSION

Obesity was significantly found to be associated with increased incidence of surgical wound infections post C-sections. For that, policies should involve weight control from the beginning of pregnancy, which can involve dietary consultation and healthy life style, which is not applied in the developing countries. In addition, more focused wound assessment and treatment for those obese patients who underwent C-section surgeries to decrease the incidence of surgical wound infection among this population. Our study reported high incidence of suture infections among the patients and its' development to SSI among some of them, which highlights the need for more studies that focuses on the possible causes and the importance of post discharge survey to detect suture

infections even at home and treat them at early stages. Other studies are needed to determine associated risk factors for wound infections among patients undergoing this type of surgery.

- **Patient Consent Form:** All participants were informed about subject of the study.
- **Author's contribution:** The author was involved in all steps of the preparation of this study including final proofreading.
- **Conflicts of interest:** There are no conflicts of interest.
- **Financial support and sponsorship:** None.

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