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Incidence and risk factors associated with surgical site infection among patients that underwent stoma reversal at a Saudi tertiary hospital

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ABSTRACT

Background: Stoma reversal is used to reconnect the area after a colostomy or ileostomy. There are multiple post-operative complications associated with stoma reversal, most commonly surgical site infection (SSI). *Aim:* The aim is to determine the incidence rate of SSI in stoma reversal and to assess possible risk factors associated with SSI in stoma reversal patients by analyzing operative and non-operative variables. *Methods:* This retrospective cohort study was done at the surgery department of king Abdulaziz medical city (KAMC) in Riyadh. All stoma reversal surgeries were either emergent or elective, open or laparoscopic and ileostomy or colostomy. Malignant and benign diseases were included. *Results:* Out of the 123 patients, 14 developed SSI representing 11.4%. The time to reversal was longer among patients with SSI compared to those without SSI. Significance was related to patients undergoing primary vs. secondary skin closure. *Conclusion:* There was no significance of the patient's primary disease and comorbidities and development of SSI. However, a longer time period between the stoma creation and stoma reversal and primary skin closure were associated with higher risk of SSI.

Keywords: Surgical Site Infection, Stoma Reversal, Incidence, Risk Factors.

1. INTRODUCTION

A stoma is a surgical opening that connects the abdominal wall to the small intestine (by ileostomy) or the large bowel (by colostomy) to facilitate eliminating waste in patients with malignant or inflammatory gastrointestinal diseases e.g., bowel cancer and inflammatory bowel diseases. On the other hand, stoma reversal (SR) is a common procedure done for stoma patients to rejoin the parts of the colon or small intestine that were used for the opening of the stoma thus, re-establishing the flow of waste through the

gastrointestinal tract.

Surgical site infection (SSI) is described by the Centers for Disease Control and Prevention (CDC) as a wound infection that develops within 30 days following surgery in the area of the body where the surgery was performed or within a year if an implant is left in place and the infection is thought to be secondary to surgery (Berríos-Torres et al., 2017). In the literature, the most common complication associated with SR is SSI with a reported incidence of SSI following stoma reversal ranging from 2% to 40% (Hu et al., 2018; Marquez et al., 2010). A single-center study published in 2014 shows that the incidence of SSI after SR is 36%. Also, it revealed four independent predictors for SSI after stoma reversal: A history of fascia dehiscence, thicker subcutaneous fat, presence of a colostomy and African-American race (Liang et al., 2013). A large cohort study on 528 SR patients shows that the incidence of SSI was 6.8%. Also, the study investigated the predictors for SSI and revealed that smoking is a significant predictor (Chu et al., 2015). In a recent study on 182 SR patients, 53 (29.1%) developed SSI. The same study developed a scoring system for predicting SSI in SR. The scoring system is based on three variables: Subcutaneous fat thickness 20 mm, the period from stoma creation 20 weeks and SSI after the primary operation (Kamada et al., 2021). This study aims to determine the incidence rate of SSI among patients that underwent SR at our tertiary hospital and to assess possible risk factors associated with developing SSI after SR in relation to operative and non-operative variables.

2. METHODS

A retrospective cohort study was conducted at the surgery department of king Abdulaziz medical city (KAMC) in Riyadh. The study was performed from April 2022 to December 2022. The study was approved by King Abdullah international medical research center Institutional Review Board. All stoma reversal surgery performed whether it was an emergent or elective, open or laparoscopic approach, malignant disease such as colorectal cancer or benign disease such as ulcerative colitis was included in this study. Moreover, two types of stoma reversal surgery were included; ileostomy and colostomy.

Data of 123 patients were analyzed in the current study. We obtained data regarding patient demographics, history, physical examination, clinical diagnosis and clinical indication for patients who underwent stoma reversal surgery from records maintained by the department of surgery. Also, operative data obtained such as type of skin closure in stoma reversal: Primary or secondary closure, open or laparoscopic approach, elective or emergent reversal, ASA score and the period from stoma creation to reversal.

Patients' files were reviewed for 30 days after stoma reversal to obtain data on SSI, such as the presence of purulent drainage from the surgical site, wound culture and the presence of signs and symptoms of inflammation. We followed the CDC criteria for superficial SSI in our study.

Data analysis was performed using R Studio (R version 4.1.1). Frequencies and percentages were used to express categorical data, whereas numerical data were presented as median and interquartile ranges (IQRs). The incidence of surgical site infection (SSI) was assessed using a one-proportion test with continuity correction. Factors associated with the incidence of SSI were assessed using a Fisher's exact test or a Pearson's Chi-squared test for categorical data and a Wilcoxon rank sum test for continuous variables. Statistical significance was deemed at $p < 0.05$.

3. RESULTS

Demographic and health-related characteristics

Data of 123 patients were analyzed in the current study. Approximately two-thirds of patients were males (62.6%). The median (IQR) age was 55.0 years (40.5, 65.0) and the median (IQR) BMI was 25.6 kg/m 2 (22.2, 29.2). More than one-third of the sample had diabetes mellitus (38.2%) and hypertension (34.1%), and 8.1% of them had cardiac diseases. Smokers represented 13.9% of the sample. The majority of patients (90.2%) had an ASA score of III or IV (Table 1).

Operative and stoma-related characteristics

Colorectal cancers were the most common primary diseases that necessitated stoma (52.0%), while inflammatory bowel disease (Crohn's disease or ulcerative colitis) was the primary disease among 14.6% of patients. The majority of surgeries were elective (92.7%) and the open approach was implemented in 71.5% of operations. More than half of skin closures were secondary (56.2%) and the remaining surgeries were primary (43.8%). Ileostomies were performed among 62.6% of patients and the remainders (37.4%) underwent colostomy procedures. The median (IQR) time to stoma reversal among all the patients was 286.0 days (163.8, 464.2) (Table 2).

Table 1 Demographic and health-related characteristics and their association with surgical site infection

Parameter	Category	Overall, N = 123	SSI		
			No, N = 109	Yes, N = 14	p-value
Gender	Male	77 (62.6%)	68 (62.4%)	9 (64.3%)	0.890
	Female	46 (37.4%)	41 (37.6%)	5 (35.7%)	
Age*	Year	55.0 (40.5, 65.0)	58.0 (40.0, 67.0)	52.5 (44.5, 59.5)	0.403
Weight*	Kg	65.5 (58.0, 79.0)	65.5 (58.0, 79.0)	65.2 (54.4, 79.8)	0.889
Height*	Cm	164.0 (156.0, 170.0)	164.0 (156.0, 170.0)	164.0 (152.8, 169.2)	0.705
BMI*	kg/m^2	25.6 (22.2, 29.2)	25.6 (22.6, 29.1)	23.8 (22.2, 29.7)	0.858
DM	Yes	47 (38.2%)	40 (36.7%)	7 (50.0%)	0.335
HTN	Yes	42 (34.1%)	37 (33.9%)	5 (35.7%)	>0.999
CKD	Yes	10 (8.1%)	8 (7.3%)	2 (14.3%)	0.318
Cardiac Diseases	Yes	7 (5.7%)	7 (6.4%)	0 (0.0%)	>0.999
Smoking¥	Yes	17 (13.9%)	14 (13.0%)	3 (21.4%)	0.412
ASA score¥	I	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.657
	II	3 (2.5%)	3 (2.8%)	0 (0.0%)	
	III	56 (45.9%)	50 (46.3%)	6 (42.9%)	
	IV	54 (44.3%)	48 (44.4%)	6 (42.9%)	
	V	9 (7.4%)	7 (6.5%)	2 (14.3%)	

**variables are expressed as median (interquartile range); otherwise, variables are presented as frequencies (percentages)*

¥the variable has one missing value

SSI: Surgical site infection; BMI: Body mass index; DM: Diabetes mellitus; HTN: Hypertension; CKD: Chronic kidney disease

ASA: American Society of Anesthesiologists

Surgical site infection and the associated factors

In general, 14 patients developed SSI, which represents 11.4% of the sample (95% CI, 6.6 to 18.7). Results of the univariate analysis showed that there were no significant differences between patients with and without SSI in terms of demographic characteristics, comorbidities and American Society of Anesthesiologists scores (ASA scores) (Table 1). The characteristics of surgeries (urgency and the surgical approach) were not significantly different among patients with and without SSI (Table 2). However, the time to stoma reversal was significantly longer among patients with SSI (median = 560.0 days, IQR = 289.0 to 878.0) compared to those without SSI (median = 281.0 days, IQR = 158.0 to 406.0, p = 0.015) (Table 2) (Figure 1).

Table 2 Operative and stoma-related characteristics and their association with surgical site infection

Parameter	Category	Overall, N = 123	SSI		
			No, N = 109	Yes, N = 14	p-value
Reason for stoma	Colorectal cancers	64 (52.0%)	56 (51.4%)	8 (57.1%)	>0.999
	IBD	18 (14.6%)	16 (14.7%)	2 (14.3%)	
	Necrotizing fasciitis	4 (3.3%)	4 (3.7%)	0 (0.0%)	
	Others	37 (30.1%)	33 (30.3%)	4 (28.6%)	
Type of stoma	Ileostomy	77 (62.6%)	71 (65.1%)	6 (42.9%)	0.105
	Colostomy	46 (37.4%)	38 (34.9%)	8 (57.1%)	
Elective or emergency	Elective	114 (92.7%)	102 (93.6%)	12 (85.7%)	0.272
	Emergency	9 (7.3%)	7 (6.4%)	2 (14.3%)	
Open or lap	Open	88 (71.5%)	78 (71.6%)	10 (71.4%)	0.382
	Laparotomy	1 (0.8%)	1 (0.9%)	0 (0.0%)	
	Laparoscopic	32 (26.0%)	29 (26.6%)	3 (21.4%)	
	Not mentioned	2 (1.6%)	1 (0.9%)	1 (7.1%)	
Time to reversal*	Days	286.0 (163.8, 464.2)	281.0 (158.0, 406.0)	560.0 (289.0, 878.0)	0.015
Primary Vs Secondary skin closure¥	Primary	53 (43.8%)	44 (40.7%)	9 (69.2%)	0.050
	Secondary	68 (56.2%)	64 (59.3%)	4 (30.8%)	

**The variable has 11 missing values, and it was expressed as median (interquartile range)*

¥ The variable has 2 missing values

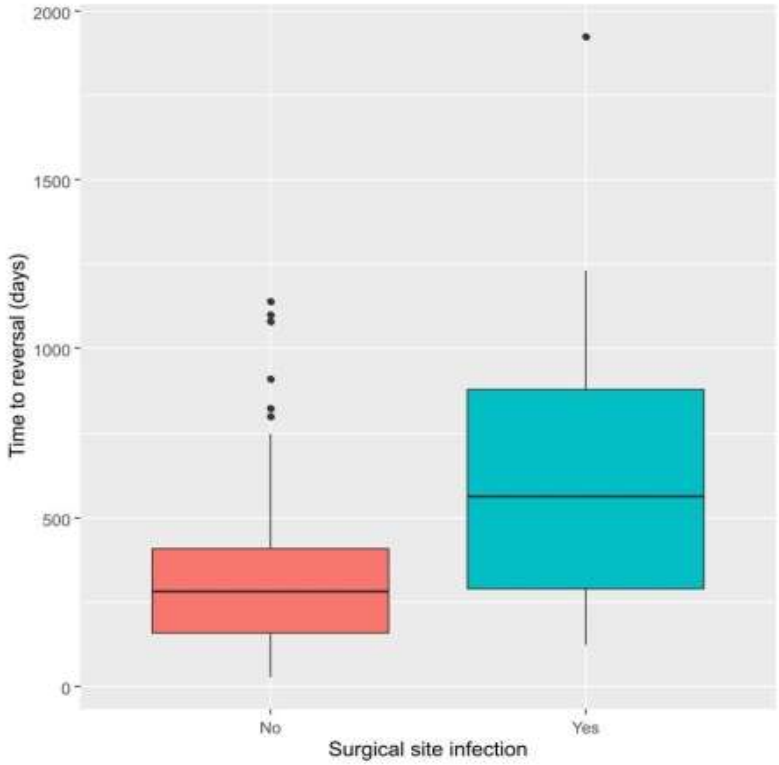

Figure 1 Boxplots showing the median values of time required to reversal based on the incidence of surgical site infection

4. DISCUSSION

In this study of SSI among patients that underwent SR, the observed rate of SSI after SR was 11.4%. The time to stoma reversal was found to have a significant association of developing SSI after SR. Patients that had developed SSI after SR were associated with having a longer duration between undergoing the initial stoma creation and later on undergoing SR. Another significant association was related to patients undergoing either primary vs. secondary skin closure and later on developing SSI after SR. A higher number of patients that developed SSI underwent primary skin closure in comparison to secondary skin closure.

There is a multitude of studies in the literature with varying reported incidence rates of SSIs after SR. A recent study published in 2022 reported within their cohort of 201 patients that underwent elective ileostomy reversal that 18.4% (n=37) of them developed postoperative SSI (Zhu et al., 2022). Another recent study published in 2021 by Kamada et al., (2021) reported an incidence rate of SSI of 29.1% (n=53) among their cohort of patients that underwent elective SR. Liang et al., (2013) reported that among their cohort of patients that underwent SR that 36% (n=46) developed postoperative SSI. A study by Chu et al., (2015) reviewed 528 patients who underwent SR and reported a SSI rate of 6.8% (n=36). Our findings report that among our cohort of 123 patients that underwent SR 11.4% (n=14) developed postoperative SSI. The type of stoma, such as a patient undergoing an ileostomy or a colostomy, was not found to be significantly associated with developing postoperative SSI. Nor was there a significant association between developing postoperative SSI and whether the SR underwent as an elective or an emergency operation. What may implicate and explain the wide range of reported rates of incidence of postoperative SSI among the published reports in the literature was the heterogeneous nature of the sample of patients and procedural characteristics among the different hospitals and medical centers where the studies underwent.

The type of skin closure in regards to reducing the risk of SSI after SR has been explored by a number of studies in the literature. Options for skin closure include primary closure using subcuticular sutures or staples, secondary closure using wet-to-dry dressings or the purse-string technique or tertiary/delayed closure. In our sample of patients, 56.2% (n=68) of skin closures were secondary and 43.8% (n=53) were primary. There was a greater incidence of SSI in primary surgical closure compared to secondary, which is seem to be consistent with prior studies in the literature. One meta-analysis by Rondelli et al., (2018) comparing outcomes between Purse-String Closure (PSC) and Conventional Closure Technique (CCT) for skin closure after SR found that the rate of SSI was statistically significantly lower when PSC is utilized rather than CCT. In a nonrandomized prospective observational study

comparing between PSC and primary linear skin closure, reported a similar conclusion that the primary linear skin closure group had a statistically significant higher rate of SSI after SR in comparison to the PSC group (Bains et al., 2022). Sayuen et al., (2022) conducted a study comparing between PSC and linear closure among pediatric patients that underwent SR, they reported that there had been a significantly lower rate of SSI among the PSC group in comparison to the linear closure group. Other than options regarding skin closure, there are studies that explore the utility of negative pressure wound therapy as a method of decreasing SSI. Borejsza-Wysocki et al., (2021) conducted a pilot study comparing between Negative pressure wound therapy (NPWT) and standard sterile dressing among patients that underwent SR. They found that NPWT did not seem to have a significant benefit of reducing postoperative SSI, yet during the postoperative period the NPWT group reported a significantly lower score on the visual analogue score for pain assessment.

Other significant risk factors associated with developing postoperative SSI after SR were explored and reported in the literature. In our study, demographic variables, patient-related characteristics, presence of comorbidities and ASA classification were not found to have a statistically significant association with developing postoperative SSI. Chu et al., (2015) conclude from their findings that the SSI group had significantly higher rates of smoking and were ASA 3-4 classification. But on multivariable analysis, only smoking was significantly associated with an increased risk of developing SSI. Smoking was not found to be significantly related with a higher number of SSI cases among our cohort, but this could be explained by the limitation of our electronic health record in accurate documentation of patient-related social history and factors. Zhu et al., (2022) reported that among their sample of patients that developed SSI, there was a higher level of preoperative C - reactive protein (CRP) in comparison to the non-SSI group. Their findings suggest that preoperative CRP may serve as a predictive index for the risk of developing postoperative SSI. Kamada et al., (2021) identified three statistically significant preoperative variables as risk factors that were associated with a higher incidence of SSI after SR: Subcutaneous fat thickness of over ≥ 20 mm, a period of ≤ 20 weeks from stoma creation and SSI after the primary operation. In our cohort, we found that the time to stoma reversal had a significant association with developing postoperative SSI, with having a longer duration between undergoing the initial stoma creation and then later undergoing SR had a considerably significant association with postoperative SSI. Liang et al., (2013) identified four risk factors using multivariate analysis significantly associated with increased risk of SSI: History of facial dehiscence, presence of colostomy, thicker subcutaneous fat similar to the study done by Kamada et al., (2021) and black race.

5. CONCLUSION

Patient's primary disease and comorbidities were not a significant risk of surgical site infections. However, having a longer duration between undergoing the initial stoma creation and later undergoing stoma reversal and primary skin closer were associated with more risk of SSI. Limitations related to our study include its retrospective design and the number of valid reviewable patients and procedural-specific variables, in that there exits an element of missing-data bias. Yet, we have attempted to reduce this by using the CDC criteria.

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Author Contributions

All authors have contributed to literature review, proposal writing, data collections and management, data analysis, abstract and manuscript writing.

Ethical approval

The study was approved by the Medical Ethics Committee of King Abdullah international medical research center Institutional Review Board (Ethical approval code: IRB/0827/22).

Informed consent

Not applicable.

Data materials availability

Data that support the findings of this study are embedded within the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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