

Incidence and risk factors of surgical site infection following colorectal surgery in Iran: a prospective cohort study

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Abstract

Background

Surgical site infection (SSI) after colorectal surgery remains a significant problem for its negative clinical outcomes. The aim of this study was to determine the incidence of SSI after colorectal surgery in 5-Azar hospital of Gorgan, Golestan province, Iran and to further evaluate the related risk factors.

Methods

A prospective design was applied. Patients in the 5-Azar hospital of Gorgan, Golestan province, Iran was prospectively monitored for SSI after colorectal surgery. The demographic and perioperative characteristics were collected, and the main outcome were SSI within postoperative 30 days. Univariate analyses were used to identify risk factors.

Results

A total of 240 patients were enrolled in the study and the overall SSI rate was 23.3% (56 patients). Univariate analyses indicated that corticosteroids use (Risk Ratio (RR) = 3, 95% CI: 1.62–5.54), segmental resection with anastomosis (RR = 2.28, 95% CI: 1.12–4.63), anemia (RR = 4.52, 95% CI: 3.11–6.59), diabetics (RR = 2.68, 95% CI: 1.73–4.14), and opium use (RR = 1.87, 95% CI: 1.17–2.99) are risk factors for SSI.

Conclusions

SSI still seems to be a problem in colon surgery despite the observance of scientific principles. There are some risk factors for SSI that can be prevented.

Introduction

Colon tumors are any tumor that starts from the ileocecal region to the proximal junction of the rectosigmoid region. Colorectal cancer is one of the most important cancers in the world and the most common type of gastrointestinal cancer in Iran, which is the third most common cancer in Iranian men and the fourth in women [1–3]. Its mortality rate was 1.98 per 100,000 people per year, which accounts for 13% of deaths from gastrointestinal cancers in Iran [4]. The prevalence of this cancer is higher in industrialized countries, although in developed countries due to the Western lifestyle its incidence is increasing [5].

Despite advances in treatment, in most cases, tumor resection is still the only effective treatment [6]. Since surgery site infection is one of the most common and important diseases caused by colon and

rectum surgery and colorectal surgery is always associated with a high rate of surgical wound infection and is among the most expensive treatments in this field, various measures are taken to reduce its incidence, however, the incidence is unacceptable in many reports [7, 8].

To reduce the infectious complications of these surgeries, special methods such as mechanical bowel lavage and antibiotics are performed. For example, rinsing the entire intestine with substances such as 10% mannitol, polyethylene glycol, and normal saline is usually done the day before surgery. It is also used in various oral and injectable antibiotic regimens to reduce the normal intestinal flora. Although it does not seem possible to completely eliminate the infection in surgical patients, but taking measures to reduce the incidence of these complications after surgery can have many benefits for the patient in terms of postoperative clinical outcome, return to daily life and reduce treatment costs [9–13].

In this regard, risk assessment is a logical way to examine the potential consequences of possible accidents on individuals. In fact, it determines the effectiveness of existing control methods and provides valuable data for risk mitigation decisions, control systems, and response planning (14). Without postoperative follow-up data, estimating the rate of surgical wound infection would be erroneous (6). This doubles the need to pay attention to this. Risk factor assessment is the center of gravity of managerial and therapeutic goals that focuses on eliminating and minimizing them [14].

The aims of the present study were to establish the SSI incidence in patients undergoing colorectal surgery and to identify potentially risk factors to associated overall SSI rates.

Methods

An observational survey of prospective cohort of patients undergoing emerging or elective colorectal surgeries in Gorgan county, Iran from 2011 to 2019 in 5-Azar hospital of Gorgan was performed. Patients were identified using a hospital database of hospitalized patients and hospital records. The outcome of interest was surgical site infection (SSI), determined according to the Centers for Disease Control and Prevention (CDC) criteria [15] with a follow-up of 30 days. They are diagnosed by clinical examination based on leakage at the anastomosis site (with clinical examination and ultrasound and CTS) and abscess at the operation site (with symptoms of fever, sepsis, sonography and CTS) or by microbial culture and clinical evaluation of the surgeon.

Inclusion and exclusion criteria

All patients who undergo elective or emerging colorectal operations were included in the study.

Exclusion criteria for both types of procedures were 1) failure to provide information; 2) incomplete records of patients 2) those who died during the procedure or immediately after the surgery; 3) laparoscopic operations; 4) Stage IV cancer.

Data collection

The data was collected using a standardized checklist. Data was recorded prospectively on each patient in the database, which was completed immediately postoperatively by the operating surgeon. Data obtained included age, sex, pre-operative variables such as operation class (elective or emergency), grade of cancer (1, 2, 3), type of tumor, comorbidity, family history of cancer, smoking, opium use, and corticosteroids use; post-operative variables such as the diagnosis of SSI. The study has been performed in accordance with the Declaration of Helsinki.

Written informed consent was obtained from all individual participants in the study.

Results were shown as the mean \pm standard deviation (SD) or frequency and percentage, as appropriate. Comparisons of variables were conducted using Fisher's exact test or chi-square test, as appropriate. The variables with statistical significance in the univariate analysis will use log-binomial analysis to calculate the risk ratio (RR) of SSI within 30 days after surgery. All analyses were performed using the statistical software STATA version 16 (Stata Corp, College Station, TX). The criterion of statistical significance was $P < 0.05$.

Results

A total of 240 patients who underwent colorectal surgery were included in this study, and 56 of them developed SSI within 30 days after surgery, that is, the incidence of SSI was 23.33%. The mean age of the total number of people who underwent surgery was 56.39 ± 13.22 years, of which 128 (53.33%) were women. Of all the surgical operations performed, 80.83% were elective operations, and in 10% of cases, all surgical operations lasted more than 3 hours. In 28.33% of surgeries, it was right hemicolectomy, 55.83% was segmental resection with anastomosis and 15.83% was the segmental resection with the colostomy. The demographic and perioperative information of the patients is summarized in Table 1. Of all colon cancer patients, 46 (19.2%) had a positive family history. Of these patients, 138 (57.5%) cases had tumor resection in the left colon, 80 (33.3%) cases in the right colon and 22 (9.67) cases in the transverse colon. The type of tumor pathology in 240 patients was 234 (97.50%) adenocarcinoma and 6 cases (2.5%) lymphoma. The stages of the tumor were as follows: 31 cases (12.9%) in the stage I, 123 cases (51.2%) in the stage II, 80 cases (33.3%) in the stage III, and 6 cases (2.5%) in lymphoma.

Table 1
Demographics and perioperative characteristics of included patients

Variable	Total (n = 240)	Non-SSI group (n = 184)	SSI group (n = 56)	P-value
N (%)	240 (100)			
Age group, (N, %)				
< 65 year	174 (72.50)	38 (67.86)	136 (73.91)	0.37
> 65 year	66 (27.5)	18 (32.14)	48 (26.09)	
Age (Mean ± SD)				
Sex, (N, %)				
Men	112 (46.66)	90 (48.91)	22 (39.29)	0.20
Women	128 (53.33)	94 (51.09)	34 (60.71)	
Urgency of surgery, (N, %)				
Elective	194 (80.83)	148 (80.43)	46 (82.14)	0.77
Emergency	46 (19.67)	36 (19.57)	10 (17.57)	
Albumin level, (N, %)				
< 3	36 (15)	28 (15.22)	8 (14.29)	0.86
> 3	204 (85)	156 (84.87)	48 (85.71)	
Total protein, (N, %)				
< 5.3	20 (8.33)	14 (7.61)	6 (10.71)	0.46
> 5.3	220 (91.67)	170 (92.39)	50 (89.29)	
Duration of surgery, (N, %)				
< 3 hours	216 (90)	166 (90.22)	50 (89.29)	0.83
> 3 hours	24 (10)	18 (9.78)	6 (10.71)	
Hypertension, (N, %)				
Yes	14 (5.83)	10 (5.43)	4 (7.14)	0.63
No	226 (94.67)	174 (94.57)	52 (92.86)	
Use of corticosteroids, (N, %)				
Yes	6 (2.5)	2 (1.09)	4 (7.14)	0.01
No	234 (97.5)	182 (98.91)	52 (92.86)	

Variable	Total (n = 240)	Non-SSI group (n = 184)	SSI group (n = 56)	P-value
Site of intervention, (N, %)				
Right hemicolectomy	68 (28.33)	60 (32.61)	8 (14.29)	0.024
Segmental resection with anastomosis	134 (55.83)	98 (53.26)	36 (64.29)	
Segmental resection with colostomy	38 (15.83)	26 (14.13)	12 (21.43)	
Anemia, (N, %)				
Yes	30 (12.5)	8 (4.35)	22 (39.29)	< 0.001
No	210 (87.5)	176 (95.65)	34 (60.71)	
Diabetes, (N, %)				
Yes	36 (15)	18 (9.78)	18 (32.14)	< 0.001
No	204 (85)	166 (90.22)	38 (67.86)	
Cigarette smoking, (N, %)				
Yes	10 (4.39)	8 (4.60)	2 (3.70)	0.77
No	218 (95.61)	166 (95.40)	52 (96.30)	
Opium use, (N, %)				
Yes	48 (21.05)	30 (17.24)	18 (33.33)	0.01
No	180 (78.94)	144 (82.76)	36 (66.67)	
Opium and cigarette smoking, (N, %)				
Yes	12 (5)	10 (5.43)	2 (3.57)	0.57
No	228 (95)	174 (94.57)	54 (96.43)	

Table 1 shows the factors associated with the incidence of SSI. The risk factors significantly associated with the occurrence of SSI were use of corticosteroids (RR = 3, 95% CI: 1.62–5.54), segmental resection with anastomosis vs. right hemicolectomy (RR = 2.28, 95% CI: 1.12–4.63), anemia (RR = 4.52, 95% CI: 3.11–6.59), diabetics (RR = 2.68, 95% CI: 1.73–4.14), and opium use (RR = 1.87, 95% CI: 1.17–2.99).

Discussion

SSI is a common complication after colon surgery that causes patients to be involved with its complications and costs [16, 17]. Due to bacterial load and possible contamination during or after surgery, patients undergoing colon surgery are at high risk for SSI [18]. Therefore, knowing the status of SSI in surgical patients and identifying the factors associated with the occurrence of SSI is of particular

importance. To date, this study is one of the first studies on the incidence of SSI in northeastern Iran conducted at a colorectal referral center. Overall, in this study, we identified 56 cases (23.33%) of SSI among 240 cases of colon cancer surgery. In different studies, the results show that the incidence of SSI ranges from 3.6% [19] and 3.3% [20] to 32.1% [20], which may be due to the fact that in some studies the definition of SSI is different. Also, the period of time that patients are followed is different in each study [21–23]. It should be noted, however, that there are studies around the world that, despite having a single definition of SSI based on the CDC definition, have reported different incidence (3.3–19.9%) [20, 24–26]. By standard definition, the results of our study reported a higher incidence of SSI than many other studies. Different factors affect these differences. The first is the type of hospital where the surgery was performed. So that in most cases, the lower reported SSI rate is related to specialized hospitals, while the hospital we are studying is a governmental and educational hospital, in most cases, the surgeries were performed by students who are less skilled. The second reason for the lower reporting of SSIs in other studies is that their study is multicenter, which makes the overall incidence lower. Finally, in some studies, the study is limited to a specific type of SSI; for example, only on the complex type (deep incisional or organ-space) or the superficial type [27, 28], while our study did not distinguish between them and reported in general. Therefore, these are the cases that partially justify these differences between the findings.

The most important findings of this study were that corticosteroid use, type of surgical intervention, preoperative anemia, diabetes and opium use were the risk factors for SSI after colon surgery.

Analysis of the data from this study showed that the incidence of SSI was higher in people who took corticosteroids than in those who did not take corticosteroids. Thus, corticosteroids increase the risk of SSI up to 3 times. There have not been many studies on the effect of corticosteroids on SSI after colon surgery. However, a study by Lieber et al. [29] that examined the effect of corticosteroids on SSI after cranial surgery showed that corticosteroids could nearly double the chances of developing SSI (OR = 1.86, 95 % CI 1.03–3.37,) which is consistent with the findings of our study. The variables related to individuals of the subjects in our study, including age and sex, did not show a significant relationship with the incidence of SSI. However, in a few other studies, age was a risk factor for SSI in other surgeries [30], but in most studies for SSI, colonic surgery was not observed [22, 23, 28, 31, 32]. An interesting relationship observed in this study was that with increasing age (over 60 years) the risk of developing SSI decreases, although this relationship was not significant. In the study of Tie-Ying et al. [24], similar to the result of our research, such a result was obtained. Our study showed that the type of intervention for colon cancer was significantly associated with SSI, so that patients who had segmental resection with anastomosis had more than twice the risk of SSI compared to patients who had right hemicolectomy. Contrary to our study, the study of Marta et al. [26] did not show a significant relationship between the type of intervention and the incidence of SSI. One of the reasons that can justify these differences is that in other studies [20, 33] there is more variety of interventions, but in our study only three interventions for colon cancer have been considered. Therefore, although the results of our study have shown a significant impact of the type of intervention, however, due to the contradictory results in other studies, further investigation is needed. In our study, it was found that anemia before colon surgery is one of the risk

factors for SSI, so people with anemia were more than 4 times more likely to develop SSI. In the study of Pu-Run Lei et al., Anemia was one of the risk factors for SSI (OR: 4.591; 95% CI: 2.567–8.211). The study by Marta et al. [26] also showed that not having anemia significantly reduced the risk of SSI (OR = 0.50 95% CI: 0.29–0.89).

According to the results of our study and the results of other studies, preoperative anemia can have an independent effect on the incidence of SSI.

Many studies have shown that the incidence of SSI was higher in people with diabetes, but this incidence was not statistically significant in diabetic patients [24, 25, 33–35]. However, our study found that having diabetes significantly increased the risk of developing SSI more than doubled. Therefore, the results of the study by Marta et al. [26] confirm the findings of our study to some extent (OR = 1.85; 95% CI: 1.04–3.24).

According to the results presented in various studies that show inconsistencies in the results, the relationship between diabetes and the incidence of SSI is not clear and it is necessary to examine this relationship in an epidemiological study with good methodology or meta-analysis.

Another factor that has received less attention in other studies is the effect of drug use or addiction on the incidence of SSI in patients who have undergone surgery. However, our study examined the association between opium use and the incidence of SSI and found that opium use can significantly increase the risk of SSI by nearly two-fold. Another study by Pirkle et al. [36] on chronic opioid use showed that the risk of developing SSI in this group was significantly higher. It should be noted, however, that in most postoperative surgeries, opioids are usually prescribed to reduce pain, so showing this association will be complex and require further investigation into addicts or drug users.

In this study, patients were followed up after 30 days of discharge from the hospital through telephone interviews or review of readmission records. Data from patients who were lost in follow-up were not included in the study.

Our study has several limitations. First, this study was concentrated on colon surgery in a referral hospital; therefore, similar results may not be obtained in other populations, specialties, or hospitals. Secondly, some details should be considered before designing a study, including: blood pressure, blood sugar, dose of uses of drugs, type of wound, and adhesive incise drapes.

Conclusions

Our study indicated that the incidence of SSI after colorectal surgery is 23.3%. The prior diagnosis uses of corticosteroids, site of intervention, anemia, diabetes, and opium use may be associated with SSI incidence after colorectal surgery.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Golestan University of Medical Sciences (No. IR.GOUMS.REC.1398.203). The study has been performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all individual participants in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and security of electronic medical information but are available from the corresponding author on reasonable request.

Competing Interests

All authors report no conflicts of interest relevant to this article.

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Authors' contributions

SR and AR wrote the main manuscript text. MHT reviewed and edited the manuscript. SR and MM provided resources for this research. RA and MZ were involved in data extraction and software operation. AR performed the statistical analyses. AR, MHT and MM designed the study and contributed to the data analysis and interpretation. All authors read and approved the final manuscript.

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