Golestan University of Medical Sciences
Journal of Clinical and Basic Research
Online ISSN: 2538-3736

Research Article

# Determining Incidence of Surgical Site Infections Following Colorectal Surgery and Associated Risk Factors in a Referral and Educational Hospital in Gorgan, Northern Iran

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**Received** September 4, 2022 **Received in revised form** October 1, 2022 **Accepted** October 12, 2022

## ABSTRACT

**Background and objectives:** Surgical site infection (SSI) after colorectal surgery and its negative clinical outcomes remain significant problems. This study aimed to determine the incidence of SSI after colorectal surgery and associated risk factors in the 5 Azar Hospital of Gorgan, Iran.

**Methods:** A cross-sectional study was performed on patients undergoing emerging or elective colorectal surgeries from 2011 to 2019 in the 5 Azar Hospital of Gorgan, Iran. The subjects were followed up for 30 days. Data were collected through pre and postoperative examinations and telephone follow-ups. Univariate analyses were performed to identify risk factors.

**Results:** A total of 240 patients were enrolled in the study, and the overall SSI incidence rate was 23.3% (56 patients). Univariate analyses indicated that corticosteroids use [risk ratio (RR)=3, 95% confidence interval (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) were risk factors for SSI.

**Conclusion:** Based on our findings, the incidence of SSI after colorectal surgery is relatively high in the study area, which requires tailored approaches and careful reconsideration of the whole operation procedure. Moreover, the use of corticosteroids, type of intervention, anemia, diabetes, and opium use may be associated with the incidence of SSI after colorectal surgery. Therefore, cases with such a profile should be closely monitored after the surgery.

**Keywords:** Surgical site infection; Colorectal surgery; Risk factors; Incidence

**DOI: 10.29252/Jcbr.6.3.1**
**How to Cite:** Rajaei S, Zare M, Afghani R. Determining Incidence of Surgical Site Infections Following Colorectal Surgery and Associated Risk Factors in a Referral and Educational Hospital in Gorgan, Northern Iran. Journal of Clinical and Basic Research. 2022; 6 (3):1-9.

## Introduction

Colon tumors start 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. This cancer is also the third most common type of cancer in Iranian men and the fourth most common in women (1, 2). Colorectal cancer has an annual mortality rate of 1.98 per 100,000 people, which accounts for 13% of all deaths from gastrointestinal cancers in Iran (3). The prevalence of this cancer is higher in industrialized countries, although its incidence is increasing in developed countries due to the Western lifestyle (4).

Despite advances in treatment, in most cases, tumor resection is still the only effective treatment (5). Surgery site infection (SSI) is a frequent but important complication of colon and rectum surgery. Colorectal surgery is almost always associated with a high rate of SSI 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 (6, 7). These infections comprise 14-16% of inpatient infections (8). The duration of surgical operation is also a significant contributing factor since only 3% of operations lasting 30 minutes or less led to infection, while for operations lasting more than 6 hours this rate leaped to 18%. The risk of SSI increases with longer durations of preoperative bed stay, but preoperative showers with a disinfecting soap such as chlorhexidine or Betadine may decrease the cutaneous bacterial load (9).

To reduce the infectious complications of these surgeries, various approaches such as mechanical bowel lavage and antibiotic therapy are made. 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 eliminate the infection in surgical patients, taking measures to reduce the incidence of these complications after surgery can improve postoperative clinical outcomes, speed up the return to daily life, and reduce treatment costs (10,12). 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 (13). Without postoperative follow-up data, estimating the rate of SSIs would be erroneous (5). Assessment of associated risk factors is a key managerial and therapeutic goal that focuses on eliminating and minimizing SSIs (13). The aims of the present study were to determine the incidence of SSIs in patients undergoing colorectal surgery and to identify potential risk factors associated with overall SSI rates.

## Materials And Methods

### Study design and subjects

A cross-sectional study was performed on patients undergoing emerging or elective colorectal surgeries from 2011 to 2019 in the 5 Azar Hospital of Gorgan, Iran. Patients were identified using the hospital database of hospitalized patients and hospital records. The outcome of interest was SSI, which was determined according to the Centers for Disease Control and Prevention (CDC) criteria (14) with a follow-up of 30 days. These infections are diagnosed by clinical examination based on leakage at the anastomosis site with ultrasound and computed tomography (CT) scan and abscess at the operation site (with symptoms of fever, sepsis, sonography, and CT scan), or by microbial culture and clinical evaluation of the surgeon. The study was performed in accordance with the

Declaration of Helsinki, and written informed consent was obtained from all participants in the study.

### Data collection

Data were collected using a standardized checklist. For this purpose, data including age, sex, pre-operative variables such as operation class (elective or emergency), grade of cancer (1,3), type of tumor, comorbidity, family history of cancer, history of smoking, opium use (self-report on yes/no), and corticosteroids use, as well as postoperative variables such as the diagnosis of SSI were retrospectively recorded for each patient immediately after the operation by the surgeon.

The patients were followed up for 30 days post-discharge through telephone interviews or a review of readmission records.

### Data analysis

Results are shown as mean ± standard deviation or frequency and percentage where appropriate. The Association of variables was evaluated by Fisher's exact test or chi-square test. The variables were statistically significant in univariate analysis, and the risk ratio of surgical site infection 30 days after surgery was calculated by log-binomial regression. All analyses were performed using the statistical software STATA (version 16, Stata Corp, College Station, USA). The criterion of statistical significance was $p< 0.05$.

## Results

A total of 240 patients (128 females, 112 males) who underwent colorectal surgery were included in this study, 56 of whom developed SSI within 30 days after surgery, making the incidence rate 23.33%. The mean age of the patients was 56.39±13.22 years. The majority of surgical operations (80.83%) were elective, and in 10% of cases, the operation lasted more than 3 hours. The demographic and perioperative information of the patients is summarized in table 1. Of 240 cancer patients, 46 (19.2%) had a positive family history, 138 (57.5%) had tumor resection in the left colon, and 234 (97.50%) had adenocarcinoma. More than half of the cases had stage II cancer, and 6 cases (2.5%) had lymphoma.

As shown in table 1, the incidence of SSI was significantly associated with the use of corticosteroids [risk ratio (RR)=3, 95% confidence interval (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).

**Table 1. Demographics and perioperative characteristics of the patients undergoing colorectal surgery**

| Variable | Total (n=240) | Non-SSI Group (n=184) | SSI Group (n=56) | *p*-value |
|---|---|---|---|---|
| **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) | |
| **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 gr/dl | 36 (15) | 28 (15.22) | 8 (14.29) | 0.86* |
| < 3gr/dl | 204 (85) | 156 (84.87) | 48 (85.71) | |
| **Total protein, (N, %)** | | | | |
| <5.3 gr/dl | 20 (8.33) | 14 (7.61) | 6 (10.71) | 0.46* |
| < 5.3 gr/dl | 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) | |
| **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) | |

*Fisher's exact test, **Chi-square test, N=number of patients

## Discussion

Surgical site infection is a common complication of colon surgery that imposes great health and economic burden (15, 16). Due to bacterial load and possible contamination during or after surgery, patients undergoing colon surgery are at high risk for SSI (17). 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 to assess the incidence of SSI at a colorectal referral center in northeastern Iran. Overall, we identified 56 cases (23.33%) of SSI among 240 cases undergoing colorectal surgery. In different studies, the incidence of SSI ranged from 3.3% (18) to 32.1% (19), which may be due to the difference in the definition of SSI. In addition, the period that patients are followed may be different in each study (20, 21). It should be noted, however, that there are studies around the world that, despite having a single definition of SSI based on the CDC, have reported different incidence rates (3.3% to 19.9%) (19, 22,24). By standard definition, we found a higher incidence of SSI than most previous studies. Different factors may contribute to this high incidence rate including the type of hospital where the surgeries were performed. In most cases, the low SSI rate was related to specialized hospitals, while the hospital under our study is a governmental and educational hospital, in which, most surgeries are performed by medical students who are less skilled (9, 25). Moreover, most previous studies were multicenter, which makes the overall incidence lower. Finally, some studies have been limited to a specific type of SSI; for example, only the complex types (i.e. deep incisional or organ-space) or the superficial type (26, 27).

The most important finding of this study was that corticosteroid use, type of surgical intervention, preoperative anemia, diabetes, and opium use were the risk factors for SSI after colon surgery. Our analysis showed that the incidence of SSI was higher in people who took corticosteroids. In fact, corticosteroids use increased the risk of SSI by almost 3-folds. There have not been many studies on the effect of corticosteroids on SSI after colon surgery. However, a study by Lieber et al. (28) showed that corticosteroids could nearly double the chances of developing SSI after cranial surgery (OR = 1.86, 95 % CI 1.03–3.37), which is consistent with the findings of our study. In our study, we found no significant correlation between the age and sex of the patients with the incidence of SSI. However, in some articles, age has been mentioned as a risk factor for SSI in some surgeries, but in the majority of articles, no relationship between age and SSI in colon surgery has been reported (20, 21, 27, 30, 31). Interestingly, we observed that with age (over 60 years) the risk of developing SSI decreased, although this relationship was not significant. In our study, segmental resection with anastomosis increased the risk of SSI by 2-folds compared with right hemicolectomy. Contrary to this finding, the study of Silvestri et al. (24) did not report a significant relationship between the type of intervention and the incidence of SSI. One of the reasons that can justify this difference could be the variety of interventions performed in previous studies (19, 32) as opposed to only three interventions that have been considered for colon cancer in our study. Therefore, further investigation is needed to confirm our findings regarding the association between the type of intervention for colon cancer and the incidence of SSIs.

We observed that patients with anemia had a 4-fold higher risk of SSIs compared with those without anemia. In the study by Lei et al. (23), anemia was one of the risk factors for SSI (OR: 4.591; 95% CI: 2.567–8.211). The study by Silvestri et al. (24) 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 other studies, preoperative anemia can be an independent risk factor for SSI.

Many studies have shown that the incidence of SSI was higher in diabetic patients, but this difference was not statistically significant (22,23,32,33). However, our study found that having diabetes significantly increased the risk of developing SSI. Therefore, the results of the study by Silvestri et al. (24) confirm the findings of our study to some extent (OR = 1.85; 95% CI: 1.04–3.24). Given the contradictory results of most studies, the relationship between diabetes and the incidence of SSI needs to be further examined in meta-analysis or epidemiological studies with good methodology.

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 undergoing surgery. To address this gap, 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 2-fold. Pirkle et al. also reported that chronic opioid use significantly increased the risk of developing SSI (34). It should be noted that in most postoperative surgeries, opioids are usually prescribed to reduce pain, so showing this association will be complex and require further investigation.

Our study was focused on colon surgeries in a referral hospital; therefore, similar results may not be obtained in other populations, specialties, or hospitals. It is also recommended to consider factors such as blood pressure, blood sugar, dose of drugs administered, type of wound, and adhesive incise drapes when designing future studies.

## Conclusion

Based on our findings, the incidence of SSI after colorectal surgery is 23.3% in Gorgan, Iran, which is relatively high. This requires tailored approaches and careful reconsideration of the whole operation procedure in the studied hospital. Moreover, the use of corticosteroids, type of intervention, anemia, diabetes, and opium use may be associated with the incidence of SSI after colorectal surgery. Therefore, cases with such a profile should be closely monitored after the surgery.

## Acknowledgements

None.

## Declarations

### Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

### Ethics approvals and consent to participate

The study received approval from the Ethics Committee of Golestan University of Medical Sciences (No. IR.GOUMS.REC.1398.203). The study was performed in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants in the study.

### Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

### Authors' contributions

SR and AR wrote the main manuscript. MHT reviewed and edited the manuscript. SR and MM provided resources for this research. RA and MZ were involved in data extraction. 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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