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Risk Factors Associated with Operative Site Infection within 30 Days after Colon Surgery, in a Fourth Level. Institution in Bogotá, Colombia

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ABSTRACT
Introduction: *Surgical site infection (SSI) is considered an indicator of quality in health services. In colorectal procedures, its high prevalence is the most frequent cause of postoperative morbidity.*
Objective: *To identify factors associated with SSI in a fourth level hospital.*
Design: *Retrospective open cohort study.*
Material and methods: *We included 199 patients who underwent colorectal surgery between January 2017 and June 2019, followed up for 30 postoperative days to detect the development of SSI. Risk factors related to the patient and to the surgical procedure were evaluated.*
Results: *SSI was diagnosed in 28 patients (14%), at a median time of 7 (5-12) days after surgery. The incidence rate was 1.24% (95% CI 0.52-2.81). Organ/space SSI was detected in 15 patients (53.6%), followed by superficial SSI in 11 (39.3%). The prevalence of SSI was significantly higher in the 16 (57.1%) patients with a previous stoma (RR 3.25; 95% CI 1.68-6.29; p=0.002). The location of the stoma in the sigmoid colon also showed statistical significance (p=0.014). Although the prevalence was higher in patients with scheduled surgery (71.4%) than in emergency patients (68.4 %), this value was not statistically significant (p=0.829).*
Conclusion: *The presence of an old stoma and its sigmoid location were the risk factors most strongly related to the appearance of SSI.*

Keywords: *Colorectal Surgery; Stoma; Surgical Wound Infection; Surgical Site Infection; Risk Factors*

INTRODUCTION

Surgical site infection (SSI) is any infection, both superficial and deep, that occurs within 30 days after surgery.[1] It can be classified into three types according to its location: superficial, deep and organ/space infection. In addition, there are well-defined criteria by the Centers for Disease Control and Prevention (CDC) that allow determining the presence of SSI and categorizing it according to its location and risk factors.[2,3]

There are risk factors related to the patient and others to the surgical procedure. Among them are preexisting infection, malnutrition, obesity, low serum albumin level, advanced age, smoking, immunosuppression, diabetes mellitus, radiotherapy, emergency procedures, prolonged operative time, poor sterilization of surgical instruments, inadequate antisepsis techniques, wound contamination.[4]

Currently, this complication occupies the first place of hospital infection in the United States, with an overall incidence that varies between 8 and 38% [2,4,5], of which 2.5-14.4% are related with colorectal surgical procedures, as reported in some series.[5,6] The development of this complication is considered so important that the CDC and the Center for Medicare and Medicaid (CMS) have defined SSI as a quality indicator in health services.[5,7]

In Colombia there are no updated statistics on the subject, however, in different studies carried out in several cities, the incidence of SSI ranged between 2.1 and 3.3% of the surgical patients and at least 18% were colon surgery.[8,9] It should be added that in 2016 the Colombia Clinic reported an overall incidence of SSI of 1.9% in gastrointestinal surgical procedures, of which 22.6% were associated with colorectal surgery, a figure higher than that reported in the literature. In turn, SSI brings with it an increase not only in hospital stay, but also in health costs, which are estimated at an average of US$35 billion, according to US studies.[5,7] For its part, National publications in Colombia reveal an average cost of U$D 5,122.[10]

In summary, it is of vital importance to identify the most important risk factors related to SSI in patients undergoing colorectal surgery, in order to propose strategies to reduce the risk of its appearance and generate protocols aimed at optimizing preoperative, intraoperative and postoperative conditions to improve outcomes in this population.

Therefore, the objective of this study was to determine the incidence rate of SSI in patients undergoing colorectal surgery and to identify the risk factors associated with its presence.

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TABLE 1. RISK FACTORS FOR SSI RELATED TO THE PATIENT.

Risk factors	Patients with SSI n = 28 (%)	Patients without SSI n = 171 (%)	p
Heart failure	3 (10.7)	12 (7)	0.448
Diabetes	5 (17.9)	20 (11.7)	0.361
COPD	2 (7.1)	7 (4)	0.617
Chronic kidney disease	1 (3.6)	9 (5.3)	1
IBD	0	2 (1.2)	1
Colorectal cancer	15 (53.6)	112 (65.5)	0.223
Other neoplasms	4 (14.3)	25 (14.6)	1
Smoking	8 (28.6)	37 (21.6)	0.416
Hemoglobin media±DS	10 (35.7)	69 (40.3)	-
	13.6±2.5	13.2±2.6	-
Albumin median (range)	1 (3.6)	18 (10.5)	-
	-	3.7 (3.4-4)	-
Nutritional status	5 (17.9)	23 (13.4)	0.839
Mild malnutrition	1 (3.6)	12 (7)	
Moderate malnutrition	1 (3.6)	12 (7)	
Severe malnutrition	20 (71.4)	103 (60.2)	
Eutrophicism	1 (3.6)	15 (8.7)	
Overweight			
ASA classification	9 (32.1)	37 (21.6)	0.409
I	12 (42.9)	99 (57.9)	
II	5 (17.9)	25 (14.6)	
III	2 (7.1)	10 (5.8)	
IV			

*SSI: Surgical site infection. COPD: Chronic obstructive pulmonary disease. IBD: Inflammatory bowel disease. * Hemoglobin value was only obtained in 10/28 patients with SSI and 69/171 patients without SSI. ** Albumin value was only obtained in 1/28 patients with SS and 18/171 patients without SSI.*

MATERIAL AND METHODS

A retrospective study of open cohorts was carried out using non-probabilistic sequential sampling for convenience. We included 199 patients older than 18 years of both sexes, who underwent colorectal surgery in a fourth-level hospital, from January 2017 to June 2019. Postoperative follow-up was carried out by clinical assessment in the outpatient service of our specialty during 30 postoperative days, where those who developed SSI were identified.

Patients operated on for traumatic injuries and those reoperated on for procedures performed at another institution were excluded.

The incidence of SSI was calculated. Risk factors related to the patient (age, sex, comorbidities, medication, toxic habits, nutritional status, ASA classification) and to the surgical procedure (type of surgery and approach, type of procedure, type of wound, operative time, use of antibiotics, antisepsis, drains, meshes, staples, type of wound closure and material used, intraoperative bleeding, presence of stoma, wound protection) were evaluated.

The data were obtained from the electronic medical records and were registered in an electronic database in which quality control was performed on 10% of the records included.

This project had the approval of the Institutional Ethics Committee and was carried out under the guidelines established in the Declaration of Helsinki and local regulations.

Statistical analysis

Qualitative variables were reported as proportions, quantitative variables as means or medians according to verification of the assumption of normality with the Shapiro-Wilk test. Analysis was performed using the X2 test and Fisher's exact test for qualitative variables and the Mann-Whitney U test for quantitative variables. Univariate analysis was performed and the independent variables that were statistically significant, together with those that were clinically relevant due to their possible association with SSI and that had a value of p<0.20, were included in a logistic regression model, where the presence of SSI was used as a dependent variable. Additionally, the incidence rate of SSI was calculated. Using a backward model, the coefficients with their 95% confidence intervals were established. Variables with a p value <0.05 were considered significant. Statistical analysis was performed with STATA v.14.

RESULTS

The study included 199 patients, with a median age of 62 (range: 52-72) years, 100 (50.2%) were women. SSI was diagnosed in 28 (14%) patients, with a median time of 7 (5-12) days after surgery. Other postoperative complications included wound dehiscence in 26 (13%) patients, PE, pneumonia, and UTI in one patient each, and others in 17 patients.

The SSI incidence rate was 1.24% (95% CI: 0.52-2.81).

The most frequent type was organ/space SSI, detected in 15 (53.6%) patients, followed by superficial in 11 (39.3%), with dehiscence of the surgical wound being the main clinical manifestation observed.

Postoperative hospital stay was 9 (range: 6-16) days in patients with SSI and 5 (range: 4-9) in those without SSI (p<0.005).

Univariate analysis

The analyzed risk factors related to the patient are detailed in Table 1. None of these factors showed a significant difference between patients with and without SSI. The majority (53.6%) of SSI patients were older than 60 years, although this was not shown to be a risk factor. Similarly, the other preoperative variables analyzed such as heart failure, diabetes, COPD, chronic kidney disease, neoplasms, smoking, steroid use, ASA classification, hemoglobin, albumin, and nutritional status also did not show statistical significance.

Regarding the risk factors related to the surgical procedure, only the existence of an old stoma was significantly associated with SSI. It was observed that 32.1% of the patients who developed this complication had an old stoma (p=0.037) and the location in the sigmoid colon also showed significance (p=0.014) (Table 2). Electively operated patients presented a higher frequency (71.4%) of SSI than emergency operated patients (68.4%), although this difference was not statistically significant. No association was found between SSI and the type of resection or approach, antisepsis, use of antibiotics, or duration of surgery.

Multivariate analysis

The presence of a stoma prior to surgery was the only predictor of SSI development in the analyzed population. Risk analysis showed a RR of 3.25 (95% CI 1.68-6.29; p=0.002) for the presence of an old stoma.

DISCUSSION

In colorectal surgery, SSI is the most frequent cause of postoperative morbidity with a high prevalence (5-30%).[11] Worldwide, different strategies have been proposed for the control of preoperative, intraoperative, and postoperative risk factors that impact the decrease in the incidence of SSI, as well as in the days of hospital stay.[12,13]

As in this study, the one by Gomila et al.,[14] describes the presence of a stoma as a factor with a strong association with the development of SSI (OR 2.6; CI 95% 1.8-3.9; p = <0.001).[14] Another study by the colorectal surgery department of the Lahey Clinic in the United States on 79,775 patients agreed that the presence of stomas is a risk factor (OR 1.3; 95% CI 1.2- 1.4; p<0.001) and showed that the laparoscopic approach was a protective factor (OR 0.6; 95% CI 0.5-0.6; p<0.001).[15] In our series, given that our institution specializes in minimally invasive surgery, 74.3% of the patients had laparoscopic procedures, however, they did not differ from those who underwent conventional surgery.

In our study, conducted at a university clinic in Bogotá, the incidence rate of SSI calculated in colorectal surgery was 1.24% (95% CI: 0.52-2.81). Publications such as that of Javed et al.,[16] record a prevalence of SSI between 2-5% of all surgical procedures, with at least 8% of them being secondary to major abdominal surgery. On the other hand, a study of 515 patients conducted in 3 state hospitals in Bogotá, Colombia, reported an overall incidence of SSI of 1.1% and a 27-fold increased risk for gastrointestinal procedures.[17]

Agudelo et al.,[9] from Hospital Universitario Mayor, one of the institutions with the highest volume of colorectal surgery in Colombia, recorded an incidence of SSI of 3.3%. For its part, in our institution, statistical records from 2016 report a global prevalence of SSI of 24.6%, in

TABLE 2. RISK FACTORS FOR SSI ASSOCIATED WITH THE SURGICAL PROCEDURE.

Risk factors	Patients with SSI n = 28 (%)	Patients without SSI n = 171 (%)	p
Type of surgery			
Elective	20 (71,4)	117 (68,4)	
Urgent	8 (28,6)	54 (32,6)	0,829
Type of approach			
Laparoscopic	20 (71,4)	128 (74,8)	
Conventional	8 (28,7)	43 (25,1)	0,429
Type of procedure			
Right colectomy	6 (21,4)	67 (39,2)	
Left colectomy	8 (28,6)	48 (28)	
Sigmoidectomy	3 (10,7)	19 (11,1)	
Subtotal colectomy	0	3 (1,7)	
Anterior resection	0	6 (3,5)	
Colostomy	2 (7,1)	7 (4)	
Colostomy closure	9 (32,1)	18 (10,5)	
Ileostomy closure	0	2 (1,2)	
Gastrectomy+Colectomy	0	1 (0,6)	0,149
Antisepsis			
Chlorhexidine	27 (96,4)	170 (99,4)	
Povidone-iodine	170 (99,4)	1 (0,6)	0,262
Therapeutic antibiotic	10 (35,7)	41 (24)	0,187
Prophylactic antibiotic	23 (82,1)	119 (69,6)	0,173
Prophylactic antibiotic	1 (3,6)	6 (3,6)	1
Antibiotic scheme			
Metronidazol+Cefuroxime	12 (42,9)	53 (31)	
Metronidazol+Amikacin	2 (7,1)	31 (18,1)	
Other	10 (35,7)	64 (37,4)	
None	4 (14,3)	3 (85,2)	0,431
Wound classification			
Clean	1 (3,6)	3,6 (8,8)	
Clean contaminated	24 (82,7)	82,7 (85,4)	
Contaminated	3 (10,7)	10,7 (5,8)	0,498
Stapled suture	28 (100)	160 (93,6)	1
Mesh	0	5 (2,9)	
Hemostatic device	0	1 (0,6)	
Drain	15 (53,6)	0	
Intraoperative bleeding, ml	28 (14,2)	170 (86,3)	0,616
median(range)	100 (50-200)	130 50-250	

Continue TABLE 2	Patients with SSI n = 28 (%)	Patients without SSI n = 171 (%)	p
Stoma			
Old	9 (32,1)	25 (14,6)	
New	7 (25)	34 (19,9)	
None	12 (42,8)	112 (65.5)	0,037
Stoma type			
Ileostomy	2 (7,1)	19 (11,1)	
Sigmoid colostomy	9 (32,1)	32 (18,7)	
Transverse colostomy	5 (17,9)	6 (3,5)	
Stoma+ Mucous fistula	0	2 (1,2)	0,014
Material used for closure			
Polyglactin 910	15 (53,6)	85 (49,7)	
Polydioxanone	13 (46,4)	73 (42,7)	
Polyglyconate	0	9 (5,3)	
Others	0	4 (2,3)	0,517
Type of skin closure			
Subcuticular suture	23 (82,1)	146 (85,4)	
Interrupted suture	5 (17,9)	17 (10)	
Stapled suture	0	6 (3,5)	0,44
None	0	2 (1,2)	
Wound protection			
Plastic protector	11 (39,3)	42 (24,6)	
Adhesive and dressing	5 (17,9)	25 (14,6)	
Adhesive	12 (42,9)	94 (55)	
None	0	10 (5,8)	0,243
Operative time. minutes median (range)	180 (120-180)	150 (120-190)	0,966

SSI: Surgical site infection.

21% secondary to colon surgeries. In the present study, a prevalence of 14.7% was calculated for patients undergoing colorectal surgery, 6.3% less than that recorded in previous years and 5.2% less than that recorded by Silvestri et al.[18] where the prevalence of SSI was 19.9%.

There are multiple preoperative risk factors associated with the development of this complication of colorectal surgery, including a body mass index >25, advanced age, alcoholism, steroid use, chronic kidney or liver disease, hypoalbuminemia, diabetes mellitus, ASA classification >3, type of wound and malignancy, among others.[19,20]

One of the most important factors for the prevention of SSI, described in multiple studies worldwide, is antibiotic prophylaxis. Ho et al.,[21] suggest that the proper selection of the antibiotic regimen and the time of administration of prophylaxis considerably reduce the risk of SSI in the postoperative period of colorectal surgery.

In our study, the most widely used standardized regimen was metronidazole plus cefuroxime and only 3.5% of patients required intraoperative reinforcement; however, a significant effect of this measure in preventing SSI was not demonstrated.

Other factors to take into account are the intraoperative ones. In this regard, Pedroso et al.[22] in a study that included 911 patients undergoing colorectal surgery found that the open technique (p<0.001) and the contaminated and dirty wound (p=0.003) were strongly associated with the development of SSI, while operative time >180 min

had no statistically significant relationship.

Bertschi et al.[23] evaluated the effects of redosing antibiotics and their association with the incidence of SSI in prolonged surgeries, showing that with longer surgical time (>240 minutes), the probability is greater (p=0.031) and demonstrating in the multivariate analysis that antibiotic reinforcement decreases the incidence (OR 0.60; 95% CI 0.37-0.96; p=0.034). They used different antibiotic regimens, without giving a recommendation regarding this subject.

Other variables described in most articles are age, sex, comorbidities, use of drains, type of suture and wound protection, none of which had statistical significance in our study.

The surgery department of the Fundación Alarcón University Hospital in Madrid published a study concluding that variables such as blood transfusions (OR 1.58; 95% CI 0.4-5.1; p=0.45), use of drains (OR 3.4; 95% CI 0.7-16; p=0.11) and requirement of vasoactive drugs (OR 4.06; 95% CI: 0.8-19; p=0.08), were associated with the appearance of SSI, although without statistical significance.[24] In our study, the requirement for transfusions and vasoactive drugs as possible risk factors was not evaluated.

In the present study, the mean postoperative hospital stay was longer in patients with SSI (9 vs. 5 days; p<0.005). In contrast, this variable did not classify as a risk factor for Bohorquez et al.,[17] whose patients had an average hospital stay of 7 days.

Finally, the decision to carry out the 30-day follow-up in the study group was based on the standardized definition of the CDC's National Healthcare Surveillance Network (NHSN), which states that an SSI is any one that occurs between 30 and 90 days after a surgical procedure. This time was proposed based on the results of previous studies carried out in large cohorts of operated patients who had an annual follow-up.[25]

It is important to mention that a significant number of patients included in this study were admitted with a laparoscopic ostomy closure plan and this was the group that most frequently developed SSI, although neither the surgical procedure nor the approach as such had statistical significant relevance.

Some of the limitations of the study that we consider directly influenced the results are its retrospective nature, which made it impossible to capture data on important variables such as hemoglobin and albumin levels, and the fact that it comes from a single institution, which limits its generalization.

Another limitation that deserves mention is that although 63.8% of the operated patients had a history of colorectal cancer, this variable was not associated with a greater development of SSI when compared with patients with benign pathology. The heterogeneity between the groups, in relation to the unequal number of patients and the lack of detailed characterization of the oncologic status, did not allow accurate conclusions to be drawn about the results found in the statistical analysis.

CONCLUSIÓN

The risk factors significantly associated with the occurrence of SSI within 30 days after colorectal surgery at our institution were the presence of an old stoma and its location in the sigmoid colon.

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