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Research Article

Incidence and Risk Factors for Incisional Surgical Site Infection After Crohn's Disease Undergoing Bowel Resection

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Abstract

Background: Patients with Crohn's disease (CD) are often considered at high risk for incisional surgical site infections (SSI). The objective of this study was to identify the risk factors associated with post-operative incisional SSI in CD patients after bowel resection.

Method: CD patients undergoing bowel resection between 2015 to 2016 were enrolled. Demographic and clinical factors related to post-operative incisional SSI were analyzed using both univariate and multivariate logistic regression analyses.

Results: A total of 59 eligible patients were included in the study, of which 77.4% were male, with a mean age of 33.4 ± 11.8 years at the time of surgery. Among these, 22.0% developed post-operative incisional SSI. Factors significantly associated with a higher risk of post-operative incisional SSI included penetrating disease type (P = 0.018), bowel resection for chronic fistula (P = 0.005), and intra-operative findings of fistula (P = 0.001). Additionally, a greater proportion of patients with post-operative incisional SSI had anemia (P = 0.019), elevated white blood cell (P = 0.027) and neutrophil counts (P = 0.006), as well as a higher percentage of neutrophils (P = 0.005). Multivariate logistic regression analysis revealed that anemia (odds ratio [OR]: 3.31, 95% confidence interval [CI]: 1.05–10.46, P = 0.041), an elevated percentage of neutrophils (OR: 2.85, 95% CI: 1.23–6.59, P = 0.014), and an intra-operative finding of fistula (OR: 3.76, 95% CI: 1.53–9.21, P = 0.004) were significantly associated with the risk for post-operative incisional SSI.

Conclusions: Anemia, an elevated percentage of neutrophils, and an intra-operative finding of fistula are significant predictors of post-operative incisional SSI in CD patients undergoing bowel resection. Maintaining favorable pre-operative nutritional status and reducing inflammatory markers may help decrease the incidence of post-operative incisional SSI.

Key words: Crohn's disease; incisional surgical site infection; risk factors; bowel resection.

Introduction:

Crohn's disease (CD) is a chronic inflammatory disorder of the intestines, most commonly affecting the ileocecal region. Despite advancements in medical treatments, such as 5-aminosalicylic acid (5-ASA), corticosteroids, immunomodulators, and biologics, up to 70% of CD patients will eventually require surgery due to refractory disease or complications [1] . Furthermore, the presence of inflammation, abscesses, friable tissue, and impaired healing complicates surgical procedures in these patients. Surgical site infection (SSI) is defined as a superficial skin or deep soft-tissue infection, intra-abdominal abscess, anastomotic leak, or mucocutaneous separation of the stoma [2]. According to the Centers for Disease Control and Prevention's

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(CDC) classification, SSIs are primarily categorized as incisional or organ/space infections [3]. Previous studies have shown that the mechanisms and risk factors for incisional and organ/space SSIs differ [3, 4].
The frequency of incisional SSI in CD patients undergoing intestinal surgery ranges from 3% to 38%, with various risk factors identified across reports .Incisional SSI is one of the most common complications following intestinal resection in CD patients and is associated with prolonged hospital stays, increased costs, and a negative impact on the patient's quality of life. Therefore, identifying the risk factors for incisional SSI is critical from both an economic and epidemiological standpoint[5].
Patients undergoing bowel resection for Crohn's disease (CD) represent a high-risk cohort for incisional surgical site infections (SSI). Several potential risk factors contribute to this increased risk, including malnutrition, chronic immunosuppression, abdominal abscesses or peritonitis, anemia, intestinal obstruction, and the high incidence of emergent surgeries[6] . It is widely believed that the accompanying conditions in CD patients, such as poor nutritional status and the use of immunosuppressive agents, are linked to a higher incidence of incisional SSI. In addition to impaired host defenses, the presence of contaminated or infected wounds, such as pre-operative abscesses or peritonitis, further elevates the risk of incisional SSI [7].
In this study, we retrospectively examined the correlations between common clinicopathological variables and the risk of incisional SSI in CD patients who underwent bowel resection at our institution. Our aim was to identify diagnosis-specific risk factors for incisional SSI.

Materials and Methods

After obtaining Institutional Review Board (IRB) approval Major S.D. Singh Medical College & Hospital, a tertiary-level hospital located in Uttar Pradesh), a retrospective analysis was conducted using data from our prospectively maintained Crohn's disease (CD) database. This database includes detailed demographic, clinicopathological, surgery-related information, and outcomes. Consecutive CD patients who underwent bowel resection between 2023 to 2024. were included in the study. Both paper charts and electronic medical records were meticulously reviewed as needed.
Patients were included if they met the following criteria: (i) diagnosed with Crohn's disease, (ii) underwent bowel resection at our institution and (iii) had a minimum follow-up period of 30days after bowel resection. Exclusion from the study included: (i) surgical procedure of enterostomy instead of bowel resection and (2) only had closure of loopileostomy or colostomy.
The following demographic and clinicopathological variables were defined for the study: disease type, categorized as non-stricturing/non-perforating, stricturing, or perforating according to the Montreal classification criteria; duration from diagnosis to surgery, which represents the time interval from CD diagnosis to bowel resection; smoking status, with patients classified as current smokers, ex-smokers (ceased smoking at least six months before surgery), or non-smokers; a history of bowel resection; significant comorbidities, including congestive heart failure, coronary bypass surgery, COPD, renal insufficiency, non-gastrointestinal cancer, stroke, and liver failure; extra-intestinal manifestations such as arthralgia, pyoderma gangrenosum, erythema nodosum, PSC, CD-related ocular lesions, and thromboembolic events; autoimmune disorders including asthma, type 1 diabetes, rheumatoid arthritis, autoimmune thyroid diseases, psoriasis, lupus, autoimmune hemolytic anemia, vitiligo, celiac disease, pernicious anemia, ITP, and multiple sclerosis; prior use of biologic

therapy (infliximab, adalimumab, or certolizumab), classified based on the timing of the last dose (>3 months, 1-3 months, <1 month); elevated erythrocyte sedimentation rate (ESR >20 mm/h); elevated C-reactive protein (CRP >10 mg/L or 3 mg/L based on method); anemia (hemoglobin <120 g/L); elevated white blood cell count (>10 × 10^9/L), neutrophils (>7.5 × 10^9/L), and percentage of neutrophils (>75%); low lymphocytes (<0.8 × 10^9/L); elevated platelets (>300 × 10^9/L); and low albumin (<35 g/L).

Incisional SSIs were diagnosed by physicians according to the definitions provided by the Centers for Disease Control and Prevention (CDC) NNIS system. Incisional SSI is defined as an infection that occurs within 30days after the operation and involves the skin/subcutaneous tissue and deep soft-tissue infection of the incision. The criteria for diagnosis of incisional SSI include at least one of the following signs or symptoms: redness, heat, pain or tenderness, localized swelling and purulent drainage.

Descriptive statistics were computed for all variables. These included means and standard deviations (SDs) or medians and interquartile ranges (IQRs) for continuous factors and frequencies for categorical factors. Comparisons of the distribution of clinic pathological characteristics between the patients with or without incisional SSI were made by using the two-tailed t-testRisk factors of incisional surgical site infection (or Wilcoxon rank sum test as alternative) for continuous variables and chi-square test (or the Fisher exact test as alternative) for categorical variables. Multivariate analyses of risk factors associated with the incisional SSI were constructed using logistic regression analysis. All statistical analyses were performed with the SPSS software (version 20.0; SPSS, Chicago, IL). P-value less than 0.05 was considered statistically significant.

Results

A total of 59 patients with Crohn's disease (CD) who underwent bowel resection were enrolled in the study. Among these patients, 22.0% developed incisional surgical site infections (SSI), while 78.0% did not. The cohort consisted of 77.4 % male patients and 22.6% female patients with a mean age at CD diagnosis of 31.0 ± 11.9 years. The median duration from CD diagnosis to bowel resection was 0.6 years, with a range of 0.1 to 0.9 years. Regarding disease location, 23.9% patients had L1/L2 (ileal/colonic) involvement, 74.8% patients had L3 (ileocolic) disease, and 4.4% patients had L4 (upper gastrointestinal) involvement. In terms of disease behavior, 39.6 % patients had B1/B2 (non-stricturing and non-penetrating/stricturing) disease, while 59.1 % patients had B3 (penetrating) disease (Table 1).

Table1: Patients characteristics

Characteristic	All cases (N=59)	Patients without wound infection (N=42)	Patients with wound infection (N=17)	P-value
Age at CD diagnosis, year	31.06±11.9	30.86±12.4	31.56±9.8	0.78
Age at surgery, year	33.46±11.8	33.36±12.4	33.66±9.7	0.88
Duration from diagnosis to surgery, year	0.6 (0.1–2.9)	0.6 (0–2.8)	0.4 (0.1–3.1)	0.99
Male gender	77.4%	75.8%	82.9%	0.38
Body mass index, kg/m2	17.66±2.9	17.56±2.8	18.06±3.2	0.42
Ex or current smoker	3.1%	3.2%	2.9%	1.0
History of any drug allergy	18.2%	18.5%	17.1%	0.85
History of bowel resection	30.8%	27.4%	42.9%	0.081
Significant comorbidity	17.0%	17.7%	14.3%	0.63

History of diagnosis of UC or IC	2.5%	2.4%	2.9%	1.0
Extra-intestinal manifestations	6.3%	4.8%	11.4%	0.23
Location of CD	23.9%	27.6%	11.8%	0.056
Perianal disease	32.1%	33.9%	25.7%	0.36
Disease behavior	39.6%	45.1%	22.9%	0.018
Pre-operative use of biologics—ever	15.0%	13.7%	20.0%	0.36
Pre-operative use of biologics—3m	9.4%	8.1%	14.3%	0.32
Pre-operative use of biologics—1m	5.7%	4.8%	8.6%	0.41
Pre-operative use of immunosuppressants—ever	36.5%	35.5%	40.0%	0.62
Pre-operative use of immunosuppressants—3m	25.2%	25.0%	25.7%	0.93
Pre-operative use of immunosuppressants—1m	22.0%	23.4%	17.1%	0.43
Pre-operative use of steroids—ever	30.2%	27.4%	40.0%	0.15
Pre-operative use of steroids—3m	12.6%	10.5%	20.0%	0.15
Pre-operative use of steroids—1m	11.9%	9.7%	20.0%	0.14
Pre-operative use of 5-ASA—ever	56.0%	56.5%	54.3%	0.82
Pre-operative use of 5-ASA—3m	28.9%	29.8%	25.7%	0.64
Pre-operative use of 5-ASA—1m	23.3%	24.2%	20.0%	0.6
Pre-operative use of antibiotics—ever	22.0%	22.6%	20.0%	0.75
Pre-operative use of antibiotics—3m	17.6%	18.5%	14.3%	0.56
Pre-operative use of antibiotics—1m	17.0%	17.7%	14.3%	0.63
Elevated erythrocyte sedimentation rate	57.2%	76.3%	89.5%	0.36
Elevated C-reactive protein	56.6%	71.6%	85.0%	0.21
Anemia	73.0%	68.5%	88.6%	0.019
Elevated white blood cell	16.4%	12.9%	28.6%	0.027
Elevated neutrophils	16.4%	12.1%	31.4%	0.006
Elevated percentage of neutrophils	27.0%	21.8%	45.7%	0.005
Low lymphocytes	22.0%	25.0%	11.4%	0.087
Elevated platelet	39.6%	36.3%	51.4%	0.11
Low albumin	33.3%	32.8%	44.1%	0.22
Data are presented as mean± standard deviation or number (percentage). CD,Crohn' sdisease ; UC, ulcerativecolitis; IC, indeterminatecolitis;GI,gastrointestinal;B1,non-stricturingandnon-penetrating;B2,stricturing;B3,penetrating;L1, terminalileum;L2,colon;L3,ileocolon;L4,upperGI.5-ASA,5-aminosalicylicacid				

A higher frequency of patients who developed incisional SSI were found to have penetrating disease (77.1% vs 54.9%, p =0.018). Patients with incisional SSI were more likely to have anemia (88.6% vs 68.5%, p=0.019), but an elevated white blood cell level (28.6% vs 12.9%, p=0.027), an elevated neutrophil level (31.4% vs 12.1%, p=0.006) and an elevated percentage of neutrophils (45.7% vs 21.8%, p=0.005) (Table 1). As for surgery-related features, more patients with incisional SSI underwent surgery indicated for the presence of chronic fistula (74.3% vs 47.6%, p=0.005) and had an intra-operative finding of fistula (77.1% vs 46.8%, p=0.001) compared with those without (Table 2). There were no statistically significant differences between patients with/without incisional SSI in other clinicopathological features.

Table 2: Surgery Related features				
Characteristic	All Cases (N=59)	Patients without Wound Infection (N=42)	Patients with Wound Infection (N=17)	P-value
Chronic fistula as the indication for surgery	45	47.6	74.3	0.005
Emergent surgery	6	4.0	2.9	1.0
Laparoscopic surgery	30	21.0	11.4	0.2
Type of anastomosis				0.5
Handsewn	27	24.7	18.5	
Stapled	49	75.3	81.5	
Number of anastomosis, n (%)				0.087
0	35	25.0	11.4	
1	24	75.0	88.6	
Stoma creation	41	32.3	31.4	0.93
Intra-operative finding of fistula	45	46.8	77.1	0.001
Intra-operative finding of abscess	37	26.6	40.0	0.13
Intra-operative finding of perforation	7	4.8	2.9	1.0
Intra-operative finding of phlegmon	27	25.8	42.9	0.051
Intra-operative finding of small bowel obstruction	39	44.4	40.0	0.65
Intra-operative finding of fibrostenosis	40	58.9	48.6	0.28
Length of hospitalization, days	14 (11–22)	12.5 (10–17)	24 (18–36)	<0.001
Data are presented as median(interquartile range)or number (percentage)				

A multivariate logistic regression model was constructed to identify the risk factors associated with incisional surgical site infection (SSI) in Crohn's disease (CD) patients who underwent bowel resection. The analysis revealed that anemia (odds ratio [OR]: 3.31, 95% confidence interval [CI]: 1.05–10.46, P = 0.041), intra-operative finding of fistula (OR: 3.76, 95% CI: 1.53–9.21, P = 0.004), and an elevated percentage of neutrophils (OR: 2.85, 95% CI: 1.23–6.59, P = 0.014) were independent risk factors associated with the development of post-operative incisional SSI (Table 3).

Table 3: Multivariate analysis of risk factors associated with wound infection in patients with Crohn's disease			
Characteristic	Odds Ratio	95% Confidence Interval	P-value
Anemia (yes vs no)	3.31	1.05–10.46	0.041
Intra-operative finding of fistula (yes vs no)	3.76	1.53–9.21	0.004
Elevated percentage of neutrophils (yes vs no)	2.85	1.23–6.59	0.014

Discussion

Incisional SSI is defined as surgical site infection limited to the skin and subcutaneous tissues. The incidence of incisional SSI in patients with CD undergoing bowel resection ranges from 11% to 27% in various reports [8]. Patients with CD represent a high-risk cohort probably due to their relative immune-compromised and poor nutritional state. Given that post-operative incisional SSI is relatively common in CD patients after bowel resection, which is associated with longer durations of hospitalization, lower levels of patient satisfaction as well as increased treatment costs, awareness of risk factors for incisional SSI might promote effective preventive strategies [9].

In the current study, the incidence of incisional SSI was 22.0%, comparable to previous investigations. Anemia, elevated percentage of neutrophils, and intra-operative finding of fistula were determined to be significant predictors for post-operative incisional SSI. In a previous study found that an operating time of >180 minutes, penetrating type, and handsewn anastomosis were main risk factors for post-operative intra-abdominal septic complications [10, 11]. In addition, other risk factors formerly reported include low albumin levels, weight loss, preoperative thiopurine therapy, pre-operative steroid use, poor nutritional status, and presence of abscesses at the time of surgery. Hence, anemia and elevated percentage of neutrophils can be considered as newly verified risk factors for incisional SSI.

Pre-operative anemia has been reported to significantly increase the incidence of post-operative infectious complications and anastomotic complications after ileoanal pouch procedures [12]. A number of studies [13,14] demonstrated that perioperative blood transfusion caused by anemia was an independent risk factor for post-operative SSI . In our study, a greater proportion of patients with post-operative incisional SSI were found to have anemia. Possible explanations are as follows. First, patients with anemia typically require perioperative transfusion. Consequently, the side effects of transfusion-related immunosuppression on SSI could be a confounding factor. Second, anemia can lead to impaired tissue oxygenation, causing reduced collagen synthesis as well as impaired primary defense mechanism of oxidative killing by neutrophils.

Yamamoto et al.[15] found that intra-abdominal abscess or fistula was associated with an increased risk of SSI. Kanazawa et al[16]. Confirmed these findings using a larger population. In our study, intra-operative finding of fistula was a significant independent risk factor for post-operative incisional SSI in patients with CD. It is well known that intra-abdominal abscess and fistula could exacerbate the inflammatory status and contaminate the abdominal incision, which would seriously endanger the incision healing. Even though the finding of internal fistula during operation is a frequent situation in patients with CD, our results underlined the need for careful pre-operative assessment.

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In univariate analysis, penetrating disease was a risk factor for post-operative incisional SSI, whereas no significant differences were found in multivariate analysis. Since the patients with an intra-operative finding of fistula were almost all penetrating/B3 type of disease, these two features may have an overlapping effect on post-operative incisional SSI. In addition, patients with a history of bowel resection, location of CD as ileocolon/L3, and number of anastomosis were found to have an obvious tendency to develop post-operative incisional SSI, although statistically significant differences were not reached (P=0.081, 0.056, and 0.087, respectively), which slightly differed from the conclusion found by other authors. This might result from the retrospective design and the relatively small cohort in our study. It still remains controversial for the relationship between emergent surgery and incisional SSI in previous studies [18, 19]. We found that emergent surgery in CD did not influence the post-operative incisional SSI in our study. The small number of patients with emergent surgery included in this study might account for this.

Conclusion

Anemia, an elevated percentage of neutrophils, and an intra-operative finding of fistula are significant predictors of post-operative incisional SSI in CD patients undergoing bowel resection. Maintaining favorable pre-operative nutritional status and reducing inflammatory markers may help decrease the incidence of post-operative incisional SSI. The findings underscore the need for preoperative optimization of nutritional and hematological parameters in CD patients to reduce the risk of post-operative incisional SSI. Further large-scale prospective studies are warranted to validate these findings and improve surgical outcomes in this high-risk population.

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