

Predictive Factors of Anastomotic Leakage after Resection of Left Colon Cancer: A Single Center Experience

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ABSTRACT

Purpose: To evaluate the incidence and the different potential risk factors for the development of anastomotic leakage (AL) after resection of left-sided colon cancer. Also, to evaluate the AL impact on long-term survival outcomes.

Methods: We reviewed the cases who underwent surgical resection of left-sided colon cancer during the period between January 2008 and December 2018.

Results: 218 cases were included in our study. The commonest presentations were weight loss (45.9%), and bleeding per rectum (40.8%). Left hemi-colectomy was performed in 101 cases (46.3%) and sigmoidectomy in 117 cases (53.7%). The median operation time was 3 hours (1 – 5), and blood loss was 150 ml (50 – 750). Postoperative morbidity occurred in 28 cases (22.1%). AL occurred in 12 cases (5.5%). Early mortality occurred in 6 cases (2.8%). After median follow up of 38 months (15 – 120), mortality occurred in 44 cases (20.2%). The 1-, 3-, and 5-years overall survival (OS) were 98.8%, 84.4%, and 64.4%, respectively. Recurrence occurred in 91 cases (41.7%). The 1-, 3-, and 5-years disease-free survival (DFS) were 94.9%, 49.1%, and 38%, respectively. We did not find any significant differences between cases with and without AL in terms of OS ($p = 0.634$) and DFS ($p = 0.682$). On multivariate analysis, only preoperative serum CEA and operative blood loss were significant predictors for AL.

Conclusion: Preoperative serum CEA and operative blood loss were significant predictors for AL. AL did not have a significant impact on the survival outcomes of those cases.

Key words: colon cancer, anastomotic leakage, left hemi-colectomy, sigmoidectomy, survival

Abbreviations:

AL: anastomotic leakage;
CEA: carcino-embryonic antigen;
CA 19-9: cancer antigen 19-9;
CT: computed tomography.

INTRODUCTION

In Egypt, colorectal cancer is one of the most common malignancies. It ranks the 7th among all cancers, with about 3000 cases diagnosed in 2015 (1). Surgical resection is the main management option for patients with colon malignancies (2). Anastomotic leakage (AL) is the most dreadful complication that could occur following colorectal surgery (3). It is defined as a bowel wall defect at the site of the anastomosis, causing communication between the intra and extraluminal compartments (4). This problem could be encountered in 2% to 21% of patients

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undergoing bowel anastomosis, and it is associated with a significant short- and long-term morbidity (5-7). Hence, identification and prevention of its risk factors are crucial in current surgical practice (8,9).

Most colorectal surgeons agree with the fact that left-sided anastomoses are more prone to AL compared to the ones on the right side (10). This concept is supported by multiple facts, including; high bacterial load in the left side, proximity to the anal verge creating a high-pressure zone, and lack of peritoneal covering if the distal rectum was used in the anastomosis (10,11). Although many studies have evaluated the incidence and possible predictors of this complication, most of them were handling heterogenous colorectal pathologies (neoplastic and non-neoplastic lesions), and they were not specific for a local colonic region (right or left) (10).

The current study is conducted to estimate the incidence and the different potential risk factors for the development of AL after surgery for left-sided colon cancer. Also, to evaluate the impact of AL on the long-term outcomes of those patients.

PATIENTS AND METHODS

Study Design

This is a retrospective study for cases underwent surgical resection of left-sided colon cancer (left third of transverse colon, descending colon and sigmoid colon) at Gastrointestinal Surgery Center (GISC), Mansoura University, Egypt during the period between January 2008 and December 2018. An informed consent was obtained from all cases before surgical intervention. The current study was approved by the Ethical Committee of College of Medicine, Mansoura University.

Inclusion criteria

All cases who underwent surgical resection for left-sided colon cancer (left third of transverse colon, descending colon and sigmoid colon) in the period between January 2008 and December 2018. Both genders were included.

Exclusion criteria

Cases with left-sided colon cancer who underwent Hartmann's resection. Cases with colon cancers in the right side or the proximal transverse colon and rectal cancers. Unfit patients for general anesthesia were also excluded.

Preoperative preparation

The preoperative work up included detailed history taking, clinical examination, detailed laboratory evaluation including tumor markers [carcino-embryonic antigen (CEA) and cancer antigen 19-9 (CA 19-9)], and detailed radiological evaluation including abdominal ultrasonography and/or computed tomography (CT) with barium study. Colonoscopy was routinely performed with endoscopic biopsies were taken to conform the diagnosis of colon cancer.

Patients were admitted to the hospital few days before the planned surgical operation for both chemical and mechanical bowel preparation. Prophylactic anticoagulant therapy was given for high-risk patients.

Operative technique

Intravenous antibiotics (1 gm of 3rd generation cephalosporins and 500 mg of metronidazole infusion) were given at the time of induction. Most operations were performed via the open approach, but recently, there was a preferred trend in our center to start the case with laparoscopic approach.

Left hemicolectomy

The preferred incision was the left paramedian one and abdominal exploration was done for liver metastasis or peritoneal nodules. Left colon was mobilized along the white line moving up towards the splenic flexure. After ligation and division of vascular supply at its origin, the colon was divided proximally (at least 6 cm from tumor) and distally (at least 2-6 cm safety margin from tumor). The colorectal anastomosis was done usually in an interrupted manner and end to end configuration, and two drains were inserted, one at pelvis and the other at the left paracolic gutter.

Sigmoidectomy

The preferred incision was the left paramedian one and abdominal exploration was done for liver metastasis or peritoneal nodules. Left colon was mobilized along the white line moving up towards the splenic flexure. After ligation and division of left colic vessels, the colon was divided proximally (at least 6 cm from tumor) and distally (at least 2-6 cm safety margin from tumor). The colorectal anastomosis was done usually in an interrupted manner and end to end. Drains were inserted in the same manner as left hemicolectomy.

Postoperative care

All cases were referred to the intensive care unit or to the surgical ward according to the clinical condition. Cases were encouraged for early ambulation. Oral fluids were started after restoration of bowel sounds and solid food was started afterwards. Drains were removed and cases were discharged in absence of post-operative complications.

Follow up

The first follow up was arranged to be within 2 weeks after discharge for removal of stitches from the surgical wound and referral to the Medical Oncology Department for arrangement of adjuvant therapy. All cases included in the study were called for follow-up. The investigations that were ordered included abdominal ultrasound, contrast enhanced pelvi-abdominal CT, colonoscopy, and tumor markers (CEA and CA 19-9).

Study outcome

Primary outcomes included incidence of AL and determine different prognostic factors predicting AL after resection for left-sided colon cancers at Gastrointestinal Surgery Center (GISC), a tertiary referral center, Mansoura University, Egypt. AL was defined as an evident dehiscence of the anastomosis clinically or by abdominal computed tomography-scan and/or a pelvic abscess after left sided colon surgery diagnosed within 90-days after surgery. Secondary outcomes included perioperative outcomes, and long-term survival outcomes.

Data analysis

Shapiro-Wilk test was used to check the normality of the data distribution. Quantitative variables were expressed as median and range as appropriate while categorical variables were expressed as frequency and percentage. A survival analysis was conducted using Kaplan-Meier method and compared by Log Rank test. A binary logistic regression was run to determine possible predictors of AL among the patients in the study population.

IBM's SPSS statistics (Statistical Package for the Social Sciences) for windows (version 24) was used for statistical analysis of the collected data. All tests were conducted with 95% confidence interval. P (probability) value < 0.05 was considered statistically significant.

RESULTS

During the study period, 218 cases underwent colonic resection for left sided colonic cancer at Gastrointestinal Surgery Center, Mansoura University and were included in our study.

Preoperative characteristics

Preoperative characteristics of the study cases were summarized in *table 1*. Most of our cases were female (120 cases – 55%). The most common presentations were weight loss (100 cases – 45.9%), bleeding per rectum (89 cases – 40.8%) and abdominal pain (78 cases – 35.8%). 34 cases (15.6%) received preoperative blood transfusion. All cases underwent preoperative bowel preparation.

Table 1 - Preoperative characteristics of the study cases

Variables	Data
Age (years)	58.5 (25 – 83)
Sex	
• Male	98 (45%)
• Female	120 (55%)
Body mass index (kg/m ²)	28.2 (16.6 – 62.4)
Presentation	
• Accidental	1 (0.5%)
• Abdominal pain	78 (35.8%)
• Bleeding per rectum	89 (40.8%)
• Constipation	37 (17%)
• Intestinal obstruction	4 (1.8%)
• Diarrhea	7 (3.2%)
• Weight loss	100 (45.9%)
• Fistula	1 (0.5%)
• Urinary symptoms	1 (0.5%)
Duration of symptoms (month)	3 (0.3 – 18)
Smoking	14 (6.4%)
Comorbidities	
• Hypertension	68 (31.2%)
• Diabetes mellitus	48 (22%)
• Ischemic heart disease	10 (4.6%)
Preoperative blood transfusion	34 (15.6%)
Previous abdominal operation	77 (35.3%)
Neoadjuvant chemotherapy	5 (2.3%)
Preoperative bowel preparation	218 (100%)
Duration of bowel preparation (days)	3 (1 – 10)
Preoperative laboratory	
White blood cells (*1000/mm ³)	7 (3.4 – 15.7)
Hemoglobin (gm/dl)	11.1 (7.8 – 16.5)
Albumin (gm/dl)	4 (2.3 – 5.1)
Alanine aminotransferase (IU/L)	21 (20 – 98)
Aspartate aminotransferase (IU/L)	20 (20 – 67)
Creatinine (mg/dl)	0.7 (0.4 – 3.3)
Carcino-Embryonic Antigen (IU/L)	5.4 (0.2 – 1500)
Cancer Antigen 19-9 (IU/L)	12.3 (0.6 – 1200)

Operative data

Operative data of the study cases were summarized in *table 2*. Open approach was commonly used in our study (200 cases – 91.7%). Left hemi-colectomy was performed in 101 cases (46.3%) and sigmoidectomy was performed in 117 cases (53.7%). The median operation time was 3 hours (1 – 5), and the median blood loss was 150 ml (50 – 750). 5 cases (2.3%) required blood transfusion.

Table 2 - Operative data of the study cases (ASA, American society of anesthesiology)

Variables	Data
ASA score	
• 1	92 (42.2%)
• 2	99 (45.4%)
• 3	26 (11.9%)
• 4	1 (0.5%)
Approach	
• Open	200 (91.7%)
• Laparoscopic	4 (1.8%)
• Laparoscopy-assisted	9 (4.1%)
• Failed laparoscopy	5 (2.3%)
Liver status	
• Normal	199 (91.3%)
• Fatty	4 (1.9%)
• Fibrotic	1 (0.5%)
• Cirrhotic	14 (6.4%)
Liver metastasis	27 (1.4%)
Tumor perforation	5 (2.3%)
Type of resection	
• Left hemicolectomy	101 (46.3%)
• Sigmoidectomy	117 (53.7%)
Covering stoma	39 (17.9%)
Anastomotic technique	
• Hand-sewn	209 (95.9%)
• Stapler	9 (4.1%)
Anastomotic configuration	
• End to end	213 (97.7%)
• End to side	5 (2.3%)
Suture material	
• Vicryl	204 (93.6%)
• PDS	5 (2.3%)
• None	9 (4.1%)
Suture pattern	
• Interrupted anterior and posterior	199 (91.3%)
• Continuous anterior and posterior	8 (3.7%)
• Continuous posterior and interrupted anterior	2 (0.9%)
• None	9 (4.1%)
Seromuscular layer	
• Yes	30 (13.8%)
• N	188 (86.2%)
Operation time (hours)	3 (1 – 5)
Blood loss (ml)	150 (50 – 750)
Blood transfusion	5 (2.3%)

Pathological data

The pathological outcomes of the study cases were summarized in *table 3*. Median tumor size was 4 cm (1.5 – 12). R0 resection was performed in all cases. Lympho-vascular invasion was found in 40 cases (18.3%), and perineural invasion was found in 23 cases (10.6%).

Postoperative outcomes

The postoperative outcomes were summarized in *table 4*. The median hospital stay was 6 days (5 – 18). Postoperative morbidity occurred in 28 cases (12.8%). AL occurred in 12 cases (5.5%). Early mortality occurred in 6 cases (2.8%).

Survival outcomes

After median follow up duration of 38 month (15 – 120), mortality occurred in 44 cases (20.2%). The 1-, 3-, and 5-years OS were 98.8%, 84.4%, and 64.4%, respectively (*fig. 1*).

Recurrence occurred in 91 cases (41.7%). The median recurrence time was 25 months (8 – 115).

Table 3 - Pathological data of the study cases

Variables	Data
Pathology	
• Adenocarcinoma	187 (85.8%)
• Mucoid adenocarcinoma	23 (10.6%)
• Signet ring carcinoma	6 (2.8%)
• Mixed mucoid and signet ring carcinoma	1 (0.5%)
• Undifferentiated carcinoma	1 (0.5%)
Mass size (cm)	4 (1.5 – 12)
Number of resected lymph nodes	12 (3 – 44)
Number of positive lymph nodes	3 (1 – 24)
Radical lymph node excision	
• More than 12	119 (54.6%)
• Less than 12	99 (45.4%)
Lympho-vascular invasion	40 (18.3%)
Perineural invasion	23 (10.6%)
Safety margin	
• R0	218 (100%)
Proximal margin length (cm)	8 (1.5 – 35)
Distal margin length (cm)	6 (1 – 27)
Grade	
• I	38 (17.4%)
• II	177 (81.2%)
• III	3 (1.4%)
Stage	
• 0	1 (0.5%)
• I	28 (12.8%)
• II	106 (48.6%)
• III	71 (32.6%)
• IV	12 (5.5%)

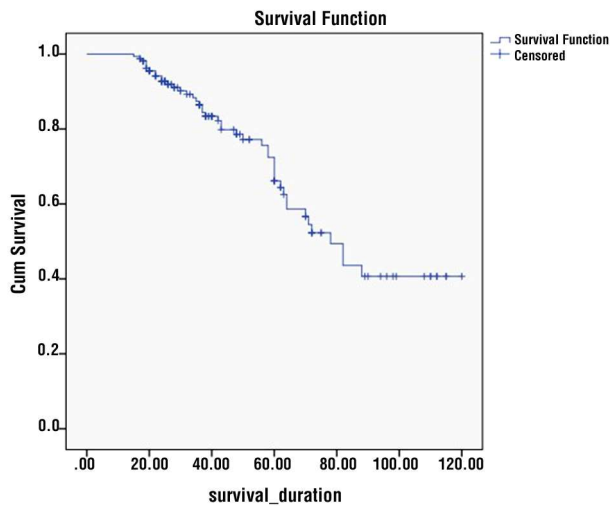


Figure 1 - Overall survival of all study cases

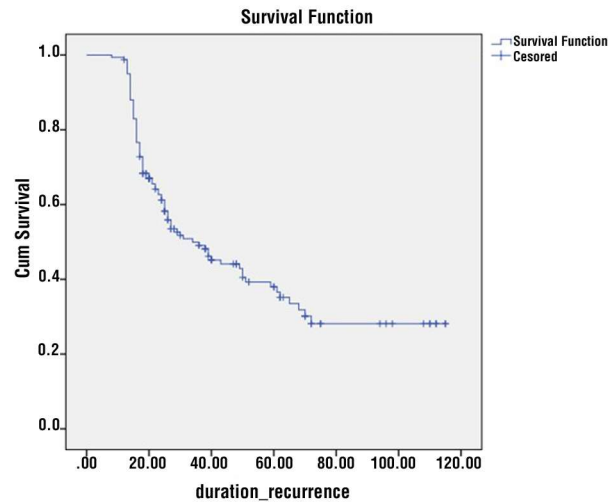


Figure 2 - Disease-free survival of all study cases

Recurrence data were summarized in *table 5*. The 1-, 3-, and 5-years DFS were 94.9%, 49.1%, and 38%, respectively (*fig. 2*).

Table 4 - Postoperative outcomes of the study cases (US, ultrasound)

Variables	Data
Ryle tube amount (ml)	195 (50 - 3030)
Ryle tube removal (days)	2 (1 – 10)
Start oral intake (days)	5 (3 – 12)
Hospital stay (days)	6 (5 – 18)
Complications	28 (12.8%)
Complication grade	
• 1	7 (3.2%)
• 2	8 (3.7%)
• 3a	3 (1.4%)
• 3b	4 (1.8%)
• 5	6 (2.8%)
Anastomotic leakage	12 (5.5%)
Leakage management	
• Conservative	6 (2.8%)
• Surgery	6 (2.8%)
Surgery type	
• Covering stoma	3 (1.4%)
• Anastomosis repair and covering stoma	2 (0.9%)
• Resection of anastomosis and new anastomosis with covering stoma	1 (0.5%)
Respiratory complications	5 (2.3%)
Abdominal collection	4 (1.8%)
Collection management	
• Conservative	1 (0.5%)
• US guided tube drainage	3 (1.4%)
Wound infection	7 (3.2%)
Wound infection management	
• Bedside management	7 (3.2%)
Early mortality	6 (2.8%)

Comparative survival outcomes according to anastomotic leakage

Overall survival

The 1-, 3-, and 5-years OS for patients without AL were 98.7%, 85.2%, and 64.6%, respectively. The 1-, 3-, and 5-years OS for patients who experienced AL were 99.4%, 71.4%, and 71.4%, respectively (Log Rank: Chi-Square = 0.226, df = 1, p = 0.634) (*fig. 3*).

Recurrence

The 1-, 3-, and 5-years DFS for patients without AL were 95.3%, 48.4%, and 37.8%, respectively. The 1-, 3-,

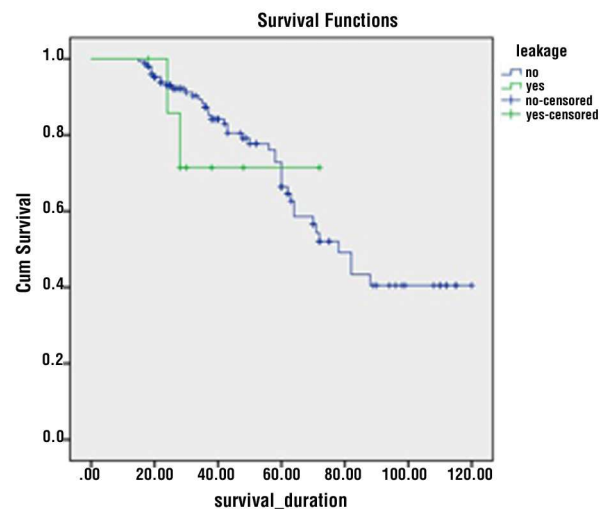


Figure 3 - Comparative overall survival of cases with and without anastomotic leak (Log Rank: Chi-Square = 0.226, df = 1, p = 0.634)

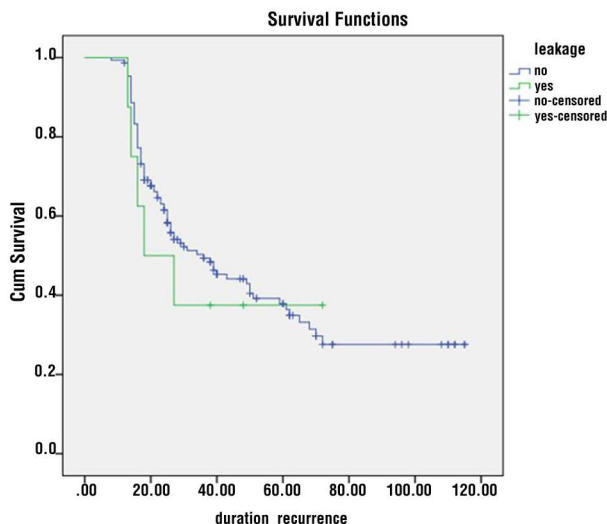


Figure 4 - Comparative disease-free survival of cases with and without anastomotic leak (Log Rank: Chi-Square = 0.167, df = 1, p = 0.682).

and 5-years DFS for patients who experienced AL were 87.5%, 37.5%, and 37.5%, respectively (Log Rank: Chi-Square = 0.167, df = 1, p = 0.682) (fig. 4).

Predictive factors of anastomotic leakage

Several perioperative and pathological variables were assessed for its relationship with AL as shown in table 6. On multivariate analysis, only preoperative serum CEA and operative blood loss were significant predictors for AL.

DISCUSSION

This study was conducted to estimate the incidence and risk factors for AL after surgery for left colonic cancer. Our findings showed that AL was encountered in 12 patients, with an incidence rate of 5.5%. This lies within the range previously reported in the introduction section, and that ensures that our incidence agrees with the normal complication rates around the globe.

In our study, age had no significant impact on the development of AL. Veyrie et al. confirmed our findings regarding age in left colonic patients (p = 0.56) (10). On the other hand, Parthasarathy et al. reported that younger patients are at higher risk of AL (12), whereas other studies liked the same complication with older age (13,14).

The current investigation noted no significant impact of gender on the development of AL. Marinello et al. confirmed our findings as the prevalence of both genders were comparable between the AL and No-AL groups (p = 0.25) (15). On the other hand, other studies

Table 5 - Recurrence data of the study cases

Variables	Data
Recurrence	91 (41.7%)
Recurrence duration	25 (8 – 115)
Recurrence site	
• Local	19 (8.7%)
• Lymph nodes	12 (5.5%)
• Liver	32 (14.7%)
• Pulmonary	7 (3.2%)
• Bone	6 (2.6%)
• Peritoneal	3 (1.4%)
• Hepatic + peritoneal	4 (1.8%)
• Hepatic + pulmonary	2 (0.9%)
• Extraluminal mass + peritoneal	1 (0.5%)
• Multi-site	5 (2.3%)
Management of recurrence	
• Surgery	16 (7.3%)
• Chemotherapy	68 (31.2%)
• Microwave ablation	2 (0.9%)
• Palliative treatment	5 (2.3%)

reported an increased risk of AL in males (16,17). This was attributed to narrow male pelvis making anastomotic creation more difficult and less favorable collagen metabolism in males compared to females (8). Our findings showed no significant relationship between BMI and AL. Another study noted a comparable prevalence of obesity in the AL and No-AL groups (p = 1.0) (10). However, another study confirmed the association between obesity and AL (18). Increased intraabdominal pressure, increased mesocolon thickness, and obesity-associated comorbidities could explain that risk (19).

In the current study, both hemoglobin and albumin had no significant impact on the development of AL. Although Leichtle and his associates reported an increased morbidity risk in patients with anemia, that risk did not include AL (20). Moreover, Jessen et al. reported a comparable incidence of preoperative anemia between the AL and No-AL groups (21). Parthasarathy et al. found that low preoperative albumin was associated with an increased risk of AL. They stressed the importance of its correction prior to the operation (12). We noted a significant association between preoperative CEA and AL in both univariate and multivariate analyses. Nonetheless, CA 19-9 did not show the same associations. Park and his colleagues did not notice our finding regarding CEA, as it had median values of 2.5 and 2.3 IU/ml in the AL and No-AL groups, respectively (p = 0.468) (3). To the best of our knowledge, there is a clear paucity of studies identifying CEA as a predictor for AL, and that should be extensively studied in the upcoming studies. Berkovich et al. addressed the significant association of elevated

Table 6 - Predictive factors of anastomotic leakage (OR, odds ratio; CI, confidence interval; BMI, body mass index; WBCs, white blood cells; CA 19-9, cancer antigen; CEA, carcino-embryonic antigen; IHD, ischemic heart disease; LV, lympho-vascular; PN, peri-neural)

Variables	Univariate analysis			Multivariate analysis		
	OR	CI	P	OR	CI	P
Age	0.038	0.027-1.885	0.17			
Sex (male/female)	-0.151	0.602-0.063	0.803			
BMI	0.092	0.05-3.35	0.067			
WBCs	-0.009	0.132-0.004	0.947			
Hemoglobin	-0.056	0.17-0.109	0.741			
Albumin	-0.363	0.596-0.371	0.542			
Creatinine	-0.77	0.334-1.332	0.563			
CA 19-9	0.002	0.001-3.71	0.054			
CEA	0.003	0.001-0.073	0.007	0.003	0.001-0.551	0.019
Smoking (yes/no)	18.044	0.213-17.2	0.999			
IHD (yes/no)	18.42	0.426-12.71	0.899			
ASA score	0.46	0.411-1.248	0.264			
Duration of symptoms	0.101	0.096-1.107	0.293			
Preoperative transfusion (yes/no)	0.116	0.799-0.021	0.885			
Type of resection (left hemicolectomy / sigmoidectomy)	0.147	0.594-0.061	0.805			
Approach (open / laparoscopy)	0.216	0.317-0.464	0.496			
Liver status (normal / cirrhosis)	0.435	0.267-2.657	0.103			
Liver metastasis (yes/no)	0.474	0.198-1.065	0.656			
Operation time	0.095	0.431-0.049	0.825			
Blood loss	0.002	0.002-0.879	0.03	0.001	0.003-0.165	0.028
Tumor perforation (yes/no)	1.519	1.16-1.715	0.19			
Covering stoma (yes/no)	-1.857	0.299-1.77	0.188			
Anastomotic technique (hand-sewn / stapler)	018.41	0.00-12.397	0.789			
Anastomotic configuration (end to end / end to side)	0.76	0.58-1.715	0.19			
Seromuscular layer (yes/no)	0.647	0.37-1.064	0.543			
Pathologic variant (adenocarcinoma / others)	0.033	0.084-0.149	0.7			
Tumor size	0.035	0.147-0.055	0.814			
LV invasion (yes/no)	0.448	0.691-0.419	0.517			
PN invasion (yes/no)	0.279	0.068-1.069	0.794			
Proximal margin length	0.052	0.05-1.086	0.297			
Distal margin length	0.104	0.095-1.188	0.276			

drain CEA level after colorectal resection and the AL. CEA is produced by mature colonic enterocytes and is present in the colon tissue as an intracellular protein. In cases of AL, enterocytes and mucosal colonic cells may be extensively detached from the disrupted anastomosis causing elevation of the levels of CEA in those patients (22).

In our study, there was no significant association between smoking and AL. Yang et al. reported no significant difference in the prevalence of smoking between the AL and No-AL groups ($p = 0.375$) (23). On the other hand, another recent report confirmed the association between smoking and AL (8). This could be explained by smoking-induced ischemia and micro-vascular disease, which have a negative impact on the anastomotic healing process (24). Ischemic heart disease did have a significant negative impact on AL in the current study. Likewise, Morse et al. reported no

significant difference in the prevalence of heart disease between the AL and No-AL groups ($p = 0.818$) (25). However, Shinji et al. denied the previous findings and reported the strong association between ischemic heart disease and AL due to the underlying intestinal microvascular disease that could disrupt circulation at the anastomotic site (26). ASA class had no significant relation with AL in the current study, and this was also reported by Park et al., who reported no significant difference between the AL and non-AL groups regarding the ASA class ($p = 0.238$) (3).

Preoperative blood transfusion was not a significant risk factor for AL in the current study. This is in contrast with several studies that reported that perioperative blood transfusion is a major predictor of AL (27,28), as transfusion induces immunosuppression which could lead to site-specific infections, including AL (29,30).

Operative data, including approach and type of

operation, did not express a significant association with AL. Other studies revealed that the operation type did not have a significant association with AL (31-33). However, others noted an increased AL risk when getting closer to the ana; verge (34-36). In our study, no significant relation was noted between operative time and AL. Morse et al. noted comparable operative durations between the AL and No-AL groups ($p = 0.053$) (25). Others contradicted the previous findings, as long operative time was thought to induce adhesions and to be related to the anastomotic site, which in turn, are associated with AL (37). Intraoperative blood loss was a significant predictor for AL in univariate and multivariate analyses in the current study. This was also confirmed in the study conducted by Leichtle and his coworkers (20). The increased blood loss may hinder the integrity of anastomotic blood supply and poor anastomotic healing (38-40). Our findings showed that tumor perforation was not a significant risk factor for AL. Another study reported that the presence of intra-operative septic complications was a strong predictor for AL ($p = 0.0012$) (40).

In this study, the creation of a stoma was not protective against the development of AL. Park et al. confirmed the same perspective, as the diversion was done for 4.8% and 6.4% of patients in the AL and No-AL groups, respectively ($p = 0.287$) (3). Despite differences in anastomotic configuration, technique, and layers, all of these variables had no significant impact on AL. Another study confirmed our perspective, as anastomotic technique and configuration were comparable among the AL and No-AL groups (15). Sultan and his colleagues also reported the previous findings (41).

The collected pathological data, including tumor type, lymphovascular status, and safety margin status, did not have a significant association with AL. Marinello et al. also confirmed the previous findings, as most of the collected pathological data were statistically comparable between the AL and No-AL groups (15).

This study has some limitations. It is retrospective in nature, and we collected patients from a single surgical institution which is liable for selection bias. Also, only elective colonic resection cases were included due to the nature of the surgical center. These drawbacks should be handled in the upcoming studies.

CONCLUSION

In conclusion, we found that only preoperative serum CEA and operative blood loss were significant predictors for AL after elective resection of left-sided

colon cancers. AL did not have a significant impact on the survival outcomes of those cases.

Conflicts of interest / Competing interest

All authors declare no conflicts of interest.

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Consent of participation and publication

An informed consent was obtained from all patients prior to surgical intervention.

Availability of data and materials

Not applicable.

Author's contributions

Conception and design of the manuscript: Shehta A, Monier A. Acquisition of the data: Elashry M, Abulazm I. Analysis and interpretation of the data: Shehta A, Abulazm IL. Drafting the manuscript: All authors. Revising the manuscript critically for important intellectual content: All authors. Final approval of the version to be submitted and any revised version: All authors.

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