Predictive factors of recurrence and survival after resection of left colon cancer

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Aim
To evaluate our center's experience of resection of left colon cancer and to determine the factors affecting both recurrence and survival after resection of left colon cancer.
Patients and methods
We reviewed patient's data who underwent colonic resection for left colon cancer during the period between January 2008 and December 2018.
Results
A total of 220 patients were included. The median age was 58.5 days (25–83 years). The most common presenting symptoms were weight loss (48.2%) and bleeding per rectum (40.9%). Sigmoidectomy was performed in 117 (53.2%) patients, whereas left hemicolectomy in 101 (45.9%) patients and Hartmann's procedure in two (0.9%) patients. The median operation time was 3 h (1–5 h), and the median blood loss was 150 ml (50–750 ml). Anastomotic leakage occurred in 13 (5.9%) patients, whereas internal hemorrhage in two (0.9%) patients.
Recurrence occurred in 92 (41.8%) patients. The 1-, 3-, and 5-year disease-free survival rates were 98.8, 51.7, and 40.5%, respectively. Mortality occurred in 43 (19.5%) patients. The 1-, 3-, and 5-year overall survival rates were 99.4, 87.7, and 72.3%, respectively. On multivariate analysis, lymphovascular emboli, perineural invasion, and tumor stage were significant predictors for recurrence, whereas serum CA19-9 and tumor stage were significant predictors for survival.
Conclusion
Identification of high-risk patients for recurrence after resection of colon cancer allows for implementation of intensive follow-up regimens and the use of adjuvant therapy.

Keywords:
colon cancer, left hemicolectomy, sigmoidectomy

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Introduction

Colorectal cancer (CRC) is the third most common cancer, and in 2008, it was the fourth most frequent cause of cancer-related death worldwide [1]. Surgical resection is the only treatment option for patients with CRC, but tumor recurrence after resection of both local and distant is associated with a high risk of cancer-related death. The majority of these recurrences occur during the first 2 years after surgery, and most follow-up programs end 5 years after the primary treatment [2].

The principal aim of postoperative surveillance in patients with CRC is to improve survival. The recurrence of CRC is for the most part a time-limited phenomenon, with 60–80% of recurrences becoming apparent within the first 2 years after resection and 90% within the first 4 years [3]. Survival in cases of early recurrence has remained persistently poor [4]. Both recurrent and metastatic disease, if detected early, might be amenable to a potentially curative surgical resection, and this will improve the patient's chances of survival [5]. This provides a rationale for a follow-up strategy in patients at high risk of early recurrence, allowing the rational use of adjuvant therapy and the implementation of intensive follow-up regimens for those at increased risk. However, there are still no uniformly accepted follow-up programs after curative resection for CRC, and very few studies have sought to identify factors that predict the time of recurrence or the pattern of recurrence [6].

Although the analyses of several studies, most of which have not included more than 400 patients, have stressed the importance of several clinical parameters such as performance status, or elevated levels of lactate dehydrogenase, white blood cell, serum albumin, liver transaminases, hemoglobin, platelets, tumor markers,

and the pathological grading or various localization of the primary tumor, presently, there is no general consensus in considering each of these parameters as valid and reliable prognostic factors [7–11].

The current study was conducted to evaluate our center's experience of resection of left colon cancer and to determine the factors affecting both recurrence and survival after resection of left colon cancer.

Patients and methods

Study design

This is a retrospective cohort study on patients who underwent resection of left colon cancer (left third of transverse colon, descending colon, and sigmoid colon) in the period between January 2008 and December 2018 at the Gastrointestinal Surgery Center, Mansoura University, Egypt. All cases were operated upon, and they were called up for follow-up at our outpatient clinics.

The current study was approved by the Ethical Committee of College of Medicine, Mansoura University. A written informed consent was obtained from each patient before the surgical procedure.

Inclusion criteria

All patients who underwent 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 were included.

Both sexes were included.

Exclusion criteria

Patients with colon cancers in the right of proximal transverse colon and rectal cancers were excluded.

Patients unfit for general anesthesia were also excluded.

Preoperative preparation

The preoperative workup included detailed history taking, clinical examination, detailed laboratory evaluation including tumor markers, and detailed radiological evaluation including abdominal ultrasonography and/or computed tomography with barium study. Colonoscopy was routinely performed, with endoscopic biopsies taken to conform the diagnosis of colon cancer.

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

Operative technique

Intravenous antibiotics (1-g third-generation cephalosporins and 500-mg intravenous metronidazole infusion) were given at the time of induction. Most operations were performed via the open approach, but recently, there has been a preferred trend in our center to start the case with the 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 toward 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 toward 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 patients were referred to the ICU or the ward. Patients were encouraged for early ambulation. Oral fluids were started after restoration of bowel sounds, and solid food was started afterward. Drains were removed, and patients were discharged in absence of postoperative complications.

Follow-up

The first follow-up was arranged to be 10 days after discharge for removal of stitches from the surgical wound and referral to the nuclear medicine 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 computed tomography, colonoscopy, and tumor markers.

Study outcome

Primary outcomes were to determine the prognostic factors for survival and recurrence after resection for left-sided colonic cancer at the Gastrointestinal Surgery Center, a tertiary referral center, Mansoura University, Egypt.

Data analysis

IBM's SPSS statistics (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA) for Windows (version 25, 2017) was used for statistical analysis of the collected data. Shapiro–Wilk test was used to check the normality of the data distribution. All tests were conducted with 95% confidence interval. *P* value less than 0.05 was considered statistically significant.

Quantitative variables were expressed as mean and SD, median, interquartile range, minimum, and maximum as appropriate, whereas categorical variables were expressed as frequency and percentage. A Cox regression was run to determine possible predictors in the studied variables of the recurrence among the patients in the study population. A survival analysis was conducted using the Kaplan–Meier graph to assess the median duration for survival in the treated patients.

Results

During the study period, 220 patients underwent colonic resection for left-sided colon cancer at the Gastrointestinal Surgery Center, Mansoura University, Egypt, and they were included in our study.

Preoperative data

The preoperative data of the study patients are summarized in Table 1. The median age was 58.5 days (25–83 days). Most of the study cases were females. The most common presenting symptoms were weight loss (106 patients – 48.2%) and bleeding per rectum (90 patients – 40.9%). Preoperative blood transfusion was required in 35 (15.9%) patients.

Table 1 Preoperative data of the study patients

Variables	Data [*n* (%)]/[median (range)]
Age (years)	58.5 (25–83)
Sex	
Male	100 (45.5)
Female	120 (54.4)
BMI (kg/m^2)	26.4 (17–62)
Smoking	14 (6.4)
Medical history	
Hypertension	68 (30.9)
Diabetes mellitus	50 (22.7)
Ischemic heart disease	10 (4.5)
Presentation	
Abdominal pain	78 (35.5)
Bleeding per rectum	90 (40.9)
Constipation	38 (17.3)
Intestinal obstruction	4 (1.8)
Diarrhea	7 (3.2)
Urinary symptoms	1 (0.5)
Fistula	1 (0.5)
Weight loss	106 (48.2)
Accidental	1 (0.5)
Preoperative laboratory results	
White blood cells (×1000/ml)	6.9 (3.4–15.7)
Hemoglobin (g)	11.1 (7.2–16.5)
Albumin (g/dl)	3.9 (2.3–5.1)
Creatinine (mg/dl)	0.7 (0.4–3.3)
Carcinoembryonic Antigen (ng/ml)	11.8 (0.2–1500)
Cancer antigen 19-9 (U/ml)	22.8 (0–1200)
Preoperative blood transfusion	35 (15.9)
Preoperative bowel preparation (days)	3 (1–10)
Neoadjuvant chemotherapy	5 (2.3)

Operative data

The operative data of the study patients are summarized in Table 2. Most of the patients were operated by the open approach (202 patients – 91.8%). Sigmoidectomy was performed in 117 (53.2%) patients, whereas left hemicolectomy was performed in 101 (45.9%) patients, and Hartmann's procedure in two (0.9%) patients. The median operation time was 3 h (1–5 h), and the median blood loss was 150 ml (50–750 ml).

Postoperative data

The postoperative data of the study patients are summarized in Table 3. The median hospital stay was 6 days (3–16 days). Anastomotic leakage occurred in 13 (5.9%) patients, whereas internal hemorrhage occurred in two (0.9%) patients. No early postoperative mortalities occurred among our study patients.

Pathological data

The pathological data of the study patients are summarized in Table 4. The median tumor size was 4 cm (2.5–12 cm). The median dissected lymph nodes were 12 nodes (5–44 nodes). Lymphovascular emboli were found in 42 (19.1%) patients, whereas perineural invasion was found in 23 (10.5%) patients.

Survival outcomes

A total of 163 (74.1%) patients attended for follow-up visits, whereas 57 (25.9%) patients were missed during follow-up. Recurrence occurred in 92 (41.8%) patients. The median recurrence time was 25 months (8–115 months). The 1-, 3-, and 5-year disease-free survival rates were 98.8, 51.7, and 40.5%, respectively (Fig. 1).

Mortality occurred in 43 (19.5%) patients. The median survival time was 38 months (15–120 months). The 1-, 3-, and 5-year overall survival rates were 99.4, 87.7, and 72.3%, respectively (Fig. 2).

Predictive factors for recurrence

On multivariate analysis, presence of lymphovascular emboli, perineural invasion, and tumor stage were significant predictors for tumor recurrence, as shown in Table 5.

Table 2 Operative data of the study patients

Variables	Data [*n* (%)]/[median (range)]
ASA score	
I	92 (41.8)
II	101 (45.9)
III	26 (11.8)
IV	1 (0.5)
Liver status	
Normal	202 (91.8)
Fatty	3 (1.4)
Fibrotic	1 (0.5)
Cirrhotic	14 (6.4)
Liver metastasis	27 (12.3)
Approach	
Open	202 (91.8)
Laparoscopy	4 (1.8)
Laparoscopy assisted	9 (4.1)
Failed laparoscopy	5 (2.3)
Resection type	
Left hemicolectomy	101 (45.9)
Sigmoidectomy	117 (53.2)
Hartmann's procedure	2 (0.9)
Covering stoma	41 (18.6)
Anastomotic technique	
Hand-sewn	211 (95.9)
Stapler	9 (4.1)
Anastomotic configuration	
End to end	216 (98.2)
Side to end	4 (1.8)
Suture material	
Vicryl	206 (97.6)
PDS	5 (2.3)
Type of suture	
Interrupted anterior and posterior	201 (91.4)
Continuous anterior and posterior	8 (3.6)
Posterior continuous and anterior interrupted	2 (0.9)
Operation time (h)	3 (1–5)
Blood loss (ml)	150 (50–750)
Blood transfusion	5 (2.3)

ASA, American Society of Anesthesiologists.

Table 3 Postoperative data of the study patients

Variables	Data [*n* (%)]/[median (range)]
Day of Ryle tube removal (days)	2 (1–10)
Start oral intake (days)	5 (1–12)
Hospital stay (days)	6 (3–16)
Anastomotic leakage	13 (5.9)
Wound infection	39 (17.7)
Wound seroma	15 (6.8)
Burst abdomen	3 (1.3)
Internal hemorrhage	2 (0.9)

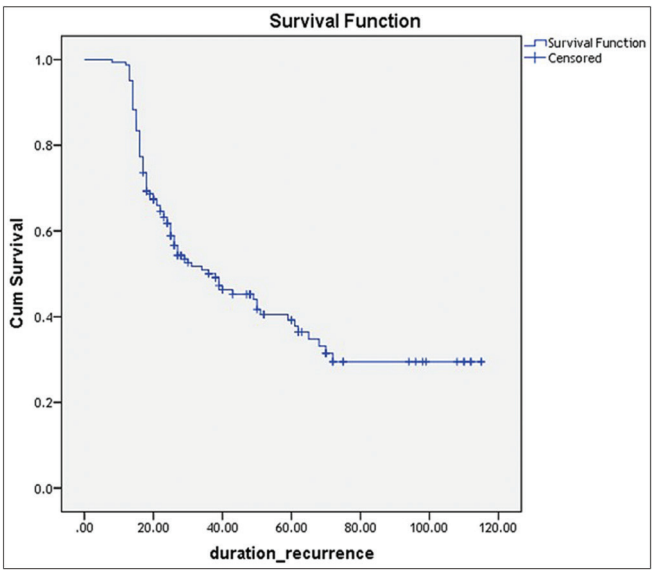
Predictive factors for survival

On multivariate analysis, CA19-9 and tumor stage were significant predictors for survival, as shown in Table 6.

Table 4 Pathological data of the study patients

Variables	Data [*n* (%)]/[median (range)]
Mass size (cm)	4 (2.5–12)
Pathologic variant	
Well differentiated Adenocarcinoma	189 (85.9)
Mucoid adenocarcinoma	20 (9.1)
Signet ring adenocarcinoma	6 (2.7)
Undifferentiated carcinoma	1 (0.5)
Mucinous carcinoma	3 (1.4)
Mixed mucinous and signet ring carcinoma	1 (0.5)
Proximal margin (cm)	8 (5–35)
Distal margin (cm)	6 (1–27)
Dissected lymph nodes	12 (5–44)
Dissected lymph nodes groups	
Less than 12	118 (53.6)
More than 12	102 (46.4)
Positive lymph nodes	0 (0–24)
Grade	
I	42 (19.1)
II	171 (77.7)
III	7 (3.2)
Stage	
0	2 (0.9)
I	28 (12.7)
II	98 (44.5)
III	79 (35.9)
IV	13 (5.9)
Lymphovascular emboli	42 (19.1)
Perineural invasion	23 (10.5)

Figure 1

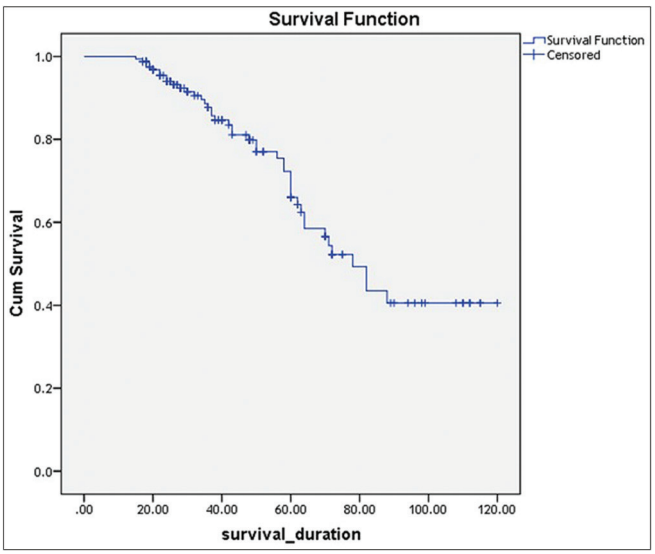


Disease-free survival of the study patients.

Discussion

CRC is one of the commonest cancers globally. Survival of CRC has improved dramatically over the past decade as a result of the invention of new drugs and targeted therapies [12].

Figure 2



Overall survival of all study patients.

This study was conducted at the Gastrointestinal Surgical Center, Mansoura University, aiming to determine the prognostic factors for both survival and recurrence after left-sided colon cancer resection. In our study, recurrence was detected in 92 (41.8%) cases out of total cases. Local recurrence was detected in 19 (8.6%) cases, whereas distant recurrence in 73 (33.1%) cases. Wilson *et al.* [13] reported that the cumulative recurrence rate between 0 and 10 years was 10.4% for local recurrence and the corresponding rate was 21.9% for distant metastasis. In a similar study by Littlechild *et al.* [14], recurrent disease was detected in 67 (25.2%) patients during follow-up, with the majority identified early within 3 years (82.1%). In our study, age was not a poor prognostic factor for either recurrence or survival. Age is a well-established prognostic factor in CRC. However, one study reported that old age (>65 years) was not a significant poor prognostic factor [13]. This agrees with our findings. On the contrary, a recent

Table 5 Predictive factors for recurrence after colectomy for left colon cancer.

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	1.002 (0.985–1.018)	0.854		
Sex	0.956 (0.634–1.441)	0.83		
BMI	1.028 (0.988–1.07)	0.167		
WBCs	0.973 (0.889–1.065)	0.549		
Hemoglobin	0.991 (0.881–1.115)	0.883		
Albumin	1.006 (0.999–1.012)	0.089		
Creatinine	0.798 (0.378–1.674)	0.547		
CEA	1.001 (0.999–1.002)	0.327		
CA 19-9	1.002 (1.001–1.003)	0.002	1 (0.998–1.002)	0.861
Smoking	0.476 (0.15–1.505)	0.206		
ASA score	1.367 (1.012–1.846)	0.042	1.453 (0.97–2.177)	0.07
Presentation	0.881 (0.727–1.067)	0.196		
Weight loss	0.898 (0.584–1.38)	0.623		
Preoperative blood transfusion	1.287 (0.739–2.24)	0.373		
Neoadjuvant therapy	1.987 (0.486–8.12)	0.339		
Liver mets	3.124 (1.681–5.806)	0.001	0.591 (0.208–1.68)	0.324
Surgeon experience	1.002 (0.833–1.205)	0.984		
Operation time	0.949 (0.703–1.281)	0.732		
Approach	0.863 (0.626–1.19)	0.369		
Liver condition	0.97 (0.706–1.333)	0.853		
Locally advanced lesion	2.365 (1.539–3.634)	0.001	1.415 (0.778–2.576)	0.255
Perforation	0.931 (0.295–2.945)	0.904		
Blood loss	1 (0.998–1.002)	0.645		
Blood transfusion	4.043 (1.258–13)	0.019	2.776 (0.465–16.562)	0.263
Postoperative pathology	1.021 (0.972–1.073)	0.399		
Mass size	1.058 (0.969–1.156)	0.21		
LV emboli	2.002 (1.248–3.211)	0.004	1.02 (1.32–3.211)	0.023
Perineural invasion	3.764 (2.282–6.209)	0.001	3.76 (1.524–9.277)	0.004
Dissected LNs	0.989 (0.962–1.017)	0.428		
Positive LN	1.127 (1.077–1.179)	0.001	0.994 (0.931–1.061)	0.848
Proximal margin	0.994 (0.953–1.036)	0.761		
Distal margin	1.006 (0.957–1.057)	0.827		
Grade	1.857 (1.089–3.164)	0.023	0.962 (0.389–2.204)	0.862
Stage	2.526 (1.903–3.352)	0.001	2.336 (1.45–3.763)	0.001
Leakage	1.243 (0.504–3.063)	0.636		

ASA, American Society of Anesthesiologists; CA 19-9, cancer antigen 19-9; CEA, carcino-embryonic antigen; CI, confidence interval; LV, left ventricular; LN, lymph node; OR, odds ratio; WBC, white blood cell.

Table 6 Predictive factors for survival after colectomy for left colon cancer

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	0.997 (0.973–1.02)	0.778		
Sex	1.017 (0.556–1.861)	0.956		
BMI	1.039 (0.977–1.105)	0.225		
WBCs	0.92 (0.8–1.059)	0.246		
Hemoglobin	0.926 (0.773–1.11)	0.408		
Albumin	0.975 (0.584–1.627)	0.923		
Creatinine	0.383 (0.1–1.474)	0.163		
CEA	1.001 (0.999–1.003)	0.242		
CA 19-9	1.003 (1.001–1.005)	0.004	1.002 (1.01–1.14)	0.046
Smoking	0.326 (0.045–2.374)	0.269		
ASA score	1.012 (0.627–1.633)	0.96		
Presentation	0.795 (0.585–1.081)	0.143		
Weight loss	0.548 (0.285–1.054)	0.072		
Preoperative blood transfusion	1.366 (0.631–2.96)	0.429		
Neoadjuvant therapy	0.048 (0–8.947)	0.681		
Liver mets	2.839 (1.172–6.874)	0.021	0.722 (0.188–2.77)	0.635
Surgeon experience	0.816 (0.602–1.106)	0.19		
Operation time	0.048 (0–3.094)	0.591		
Approach	1.022 (0.698–1.497)	0.909		
Liver condition	1.133 (0.75–1.71)	0.553		
Locally advanced lesion	2.321 (1.205–4.47)	0.012	2.02 (0.818–4.989)	0.127
Perforation	1.982 (0.611–6.43)	0.255		
Blood loss	1.001 (0.998–1.004)	0.462		
Blood transfusion	0.049 (0–14.544)	0.786		
Postoperative pathology	1.04 (0.978–1.106)	0.212		
Mass size	1.048 (0.913–1.203)	0.508		
LV emboli	1.66 (0.713–3.964)	0.24		
Perineural invasion	4.066 (1.809–9.139)	0.001	2.773 (0.641–12.005)	0.172
Dissected LNs	0.936 (0.888–0.986)	0.014	0.943 (0.869–1.024)	0.161
Positive LN	1.103 (1.042–1.168)	0.001	1.043 (0.94–1.159)	0.426
Proximal margin	0.96 (0.896–1.03)	0.257		
Distal margin	0.957 (0.87–1.054)	0.373		
Grade	1.948 (0.9–4.214)	0.091		
Stage	3.302 (2.059–5.296)	0.001	3.324 (1.614–6.477)	0.001
Leakage	1.509 (0.362–6.284)	0.572		

ASA, American Society of Anesthesiologists; CA 19-9, cancer antigen 19-9; CEA, carcino-embryonic antigen; CI, confidence interval; LV, left ventricular; LN, lymph node; OR, odds ratio; WBC, white blood cell.

study by Mima *et al.* [15] found that age more than or equal to 75 years was independently associated with a shorter recurrence-free survival and overall survival. Zimmermann *et al.* [16] reported that old age was associated with poor survival, whereas it did not have a significant negative effect on recurrence. In our study, female sex was a mild risk factor for recurrence, but it was not associated with poor survival. In a previous study by Nahas *et al.* [11], patient sex did not constitute a significant effect on neither recurrence nor survival. Besides, another study found female sex to be a significant risk factor for peritoneal recurrence [17]. In our study, BMI did not have a significant effect on recurrence or survival. A recent study reported that increased BMI was a significant risk factor for peritoneal recurrence. In addition, BMI did not have a significant effect of patient survival [17]. In our study, diabetes mellitus did have a negative effect on tumor recurrence. Besides, it was not a poor prognostic factor for survival. Another study has reported that diabetes was a significant risk factor for poor overall survival, but it did not carry a significant risk for recurrence-free interval [18]. In our study, hypertension was not a significant risk factor for recurrence but was a significant risk factor for poor survival. Conversely, another study reported that there was no association between survival and hypertension [12]. This contradicts with our findings. In our study, American Society of Anesthesiologists (ASA) status was not a significant predictor for recurrence. However, higher scores had a significant negative effect on survival. Other authors reported that ASA was not a significant risk factor for recurrence after surgery for colon cancer. In the same study, ASA score did not significantly affect patient

survival [17]. In our study, liver cirrhosis did not have a negative effect on survival. Nevertheless, it carried a mild risk for recurrence. Huang *et al.* [18] reported that liver cirrhosis was a significant risk factor for poor overall survival, whereas it did not affect recurrence-free interval. In our study, mass size did not have a significant negative effect on recurrence. Likewise, it was not a poor prognostic factor for survival. Huang *et al.* [18] reported that tumor diameter or size were not significant risk factors for either recurrence or survival. This agrees with our findings. In our study, elevated carcino-embryonic antigen (CEA) levels had a significant negative effect on patient survival. However, it did not carry a higher risk for recurrence. In a recent study, preoperative serum levels of CEA and CA19-9 were independently associated with worse recurrence-free survival or overall survival following surgery for CRC [15]. This is consistent with the findings of previous studies [16,18,19]. A population-based study with 16 619 patients with CRC reported that patients with preoperative CEA more than 5 ng/ml were independently associated with an increased risk of cancer-specific mortality and poorer prognosis in each American Joint Committee on Cancer stage [20]. In our study, preoperative hemoglobin levels were insignificant poor risk factors for recurrence or survival. Similarly, another study reported that hemoglobin levels did not have a negative effect on survival [21]. In our study, neoadjuvant chemotherapy was not a poor prognostic factor. This is concomitant with a previous study that has reported that neoadjuvant chemoradiation did not have a negative effect on survival or recurrence [16]. In our study, presentation with obstruction was not a significant risk factor for recurrence. Furthermore, it was not a poor prognostic factor for survival. Likewise, other authors reported that obstruction was not a poor prognostic factor as it was not significantly associated with 5-year recurrence [13]. This was also confirmed by other authors who reported that obstruction was a poor prognostic variable as it constituted a significant risk factor for recurrence [14]. In our study, perforation of the tumor did not have a negative effect on survival. On the contrary, it carried a high risk for recurrence. Another study reported that perforation was a poor risk factor for recurrence after colon cancer resection [13]. This was also confirmed by Littlechild *et al.* [14] who reported that perforation was a significant risk factor for recurrence. In our study, emergency surgery carried a high risk for recurrence. However, it was not associated with poor survival. Emergency resection for CRC presents a high-risk group with increased risk of early recurrence and adverse long-term survival [14]. Hogan *et al.* [22] concluded similarly that emergent surgery was associated with higher rates of local recurrence and poorer disease-free survival. In our study, higher surgeon experience was associated with a high recurrence rate. This could be explained by the fact that the higher the grade of the surgeon, the more difficult the case he/she performed, and thus, it is anticipated to find higher rates in these cases. In our study, the laparoscopic approach did not have a significant effect on patient survival. However, it had a mild risk for recurrence. Zimmermann *et al.* [16] reported that the laparoscopic approach did not significantly affect survival or recurrence after CRC resection. This agrees with our findings. In our study, mucinous adenocarcinoma was not significantly associated with recurrence or survival. Mucinous adenocarcinoma constitutes 4–19% of CRC worldwide [23]. Some studies have identified a significant association between mucinous histology and poor prognosis [2,24,25]. In the study conducted by Kanemitsu *et al.* [26], patients with mucinous adenocarcinoma had worse outcomes compared with nonmucinous types. Moreover, mucinous adenocarcinoma was associated with a 2–8% increase in the risk of death in the meta-analysis by Verhulst *et al.* [27]. In this study, such relationship was not recognized, may be owing to the small number of patients with mucinous histology. In our study, advanced tumor grade was associated with poor prognosis as it was a significant risk factor for recurrence and survival. Huang *et al.* [18] reported that poor differentiation was a significant risk factor for recurrence, whereas it did not have a significant negative effect on overall survival. Although, in another study, poor differentiation had not been correlated with worse overall survival or recurrence, it was perhaps owing to the small number (6%) of patients with this pathological condition [28]. In our study, the presence of lymphovascular emboli was a significant risk factor for poor survival and it did affect recurrence rates. Vascular invasion was also found to be an independent predictor of early all-site recurrence in a similar study by Huh *et al.* [29]. In our study, perineural invasion carried a mild risk for recurrence. However, it did have a significant negative effect on survival. Littlechild *et al.* [14] reported that perineural invasion was a poor prognostic factor for recurrence. Nevertheless, it was not significant on multivariate analysis. In our study, advanced cancer stage was associated with recurrence and poor survival. Accurate staging of colon cancer is vital to adequate oncological outcome. The need of a sufficient lymph node yield, adequate margins, and standardized operative techniques has been established [30]. Cancer stage is the most significant predictor of overall survival in colon cancer [31]. This finding agreed with other large series that studied advanced colon cancer [28,32]. A review of surveillance, epidemiology, and end results (SEER) population-based data on colon cancer by the American Joint Committee on

Cancer found that T3 has better prognosis than T4, and the number of positive nodes affects prognosis [33,34]. In our study, the number of positive lymph nodes resected had a significant negative correlation with survival. The average positive lymph nodes in the literature vary from 27 to 36% of the patients in different series [24,35]. According to the literature, which may vary between 14 and 32 lymph nodes [36,37]. Nahas *et al.* [11] reported that lymph node involvement was also associated with worse prognosis and a higher risk of death. In our study, the presence of liver metastasis had a significant negative effect on survival and later recurrence. Nahas *et al.* [11] reported that the presence of metastasis at the time of diagnosis was a significant risk factor for poor survival. In our study, anastomotic leakage was detected in 13 (5.9%) cases. It did have a negative effect on recurrence and survival. A recent report has stated that anastomotic leakage did not have a negative effect on survival or recurrence [16].Regarding survival in our study, recurrence-free survival had a median of 25 months (8–115 months). The 1-, 3-, and 5-year recurrence-free survival rates were 98.8, 51.7, and 40.5%, respectively. Overall free survival had a median of 38 (15–120 months). The 1-, 3-, and 5-year overall survival rates were 99.4, 87.7, and 72.3%, respectively. In another study, the overall survival rate at 5 and 10 years was 52.6 and 47.4%, respectively [21]. The approximate 5-year survival rate for patients with CRC in the United States (all stages included) was 65% [35]. In a previous paper, the overall survival rate was 78%, which can be considered a good result, bearing in mind that the majority of the patients included presented advanced colon cancer stage [11]. Furthermore, other authors reported that the median recurrence-free survival rate was 54.4 months with a 5-year recurrence-free survival of 49% [38]. In another study, the survival rate was 73.8%, with the mean survival time of 142.17 ± 21.60 months [39]. The variability detected between literature and our results, in some variables, could be explained by the fact that most of the studies assessing risk factors for recurrence and survival were conducted on different colonic resection cases including left colonic resections. However, there is a paucity of trials assessing the same factors for left-sided only. Several limitations have to be acknowledged. First, despite efforts to collect complete and accurate data, a retrospective review of patients from a single institution may diminish the reliability and generality of the results. Furthermore, multiple surgeons performed the surgery, and multiple pathologists evaluated the specimens. Finally, molecular and genetic studies of the tumor should have been tested, as they are documented risk factors in many studies. However, these tests are very expensive in our limited settings.

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Conflicts of interest
There are no conflicts of interest.

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