Article

The Long-Term Prognostic Outcomes of Emergent Colon Cancer Surgery: A Single-Center Experience

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AIM: Colorectal cancer (CRC) ranks as the second most diagnosed and third most deadly cancer worldwide. Despite advances in early diagnosis and treatment, CRC remains a leading cause of cancer-related deaths. Up to 30% of CRC patients are diagnosed during emergency department visits, leading to surgical procedures that may not adhere to oncological principles due to complications like obstruction, bleeding, or perforation. This study aims to compare postoperative complications and long-term oncological outcomes between emergent and elective colon cancer surgeries.

METHODS: Retrospective analysis was performed on patients who underwent surgery for colonic adenocarcinoma from January 2018 to December 2021. Patients included were those diagnosed with colonic adenocarcinoma, excluding those under 18 years old or with other pathological results. Patients were examined under the elective and emergent surgery groups. The study investigated demographic data, tumor localization, operation type, postoperative complications, and long-term oncological outcomes. A Cox proportional hazard model was used to perform multivariate analysis in order to identify prognostic variables for overall survival (OS) and disease-free survival (DFS).

RESULTS: A total of 318 patients were included, with 62 undergoing emergent surgery and 256 undergoing elective surgery. Patient demographics were similar between the groups. The emergent surgery group had a significantly lower OS rate at 50 months compared to the elective surgery group (51% vs. 62%, $p = 0.002$). DFS at 50 months was also lower for the emergent surgery group compared to the elective surgery group (43% vs. 59%), but this difference did not reach statistical significance ($p = 0.202$). Independent poor prognostic factors included stage N, stage M, tumor diameter, neural invasion, and emergent surgery status.

CONCLUSIONS: Emergency surgery for colon cancer is associated with poor long-term outcomes due to shorter OS and DFS, highlighting the need for increased awareness and screening to reduce emergency colon cancer surgery.

Keywords: colon cancer; emergent surgery; overall survival; disease-free survival

Introduction

Colorectal cancer (CRC) was the second most diagnosed cancer worldwide in 2022, with 1,926,118 cases new cases and the third leading cause of cancer-related deaths, accounting for 903,859 fatalities [1]. A decade ago, the incidence of CRC was 1,360,600 cases, and the mortality rate was 639,600 cases annually [2,3]. The increase in the number of newly diagnosed CRC over the last decade cannot be solely attributed to the increasing global population but is also due to improved data collection. It is noteworthy that despite the development of early diagnosis and advanced treatment methods, the number of cases increases at the rate of new diagnoses and maintains its place in the ranking of cancer-related deaths. The prognosis and survival rate in cancers mainly depend on the tumor stage. While the 5-year survival rate in stage I colon cancer is over 90%, this rate drops to approximately 60% in stage III [4]. In stage IV colon cancer, the 5-year survival rate ranges from 9.1% to 28.3%, depending on the treatment options received [5].

Up to 30% of CRC patients are diagnosed during emergency department visits [6,7,8]. Patients with emergency surgeries have a hospital stay that is more than 50% longer than those who have elective surgeries, resulting in considerably higher medical costs for their treatment [9]. Study has shown that postoperative morbidity is more common following emergent surgery compared to elective surgery, with higher rates of medical and surgical complications [10]. Recent studies found that emergency patients are more likely to have more postoperative complications, higher short-term mortality, and decreased overall survival (OS), including worse oncological outcomes [11,12]. This may be associated with the severe condition of the patients who are admitted as emergencies with obstruction, perforation, or bleeding. These patients typically have an advanced tumor stage, resulting in a worse prognosis and

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Table 1. Baseline characteristics between two surgery groups.

N: 318	Elective (N: 256)	Emergent (N: 62)	$t/z/\chi^2$	p
Age (years, mean ± SD)*	62.6 (±11.5)	63.98 (±14.3)	–0.760	0.448
Gender [n (%)]**			0.236	0.626
Male	145 (57%)	33 (53 %)		
Female	111 (43%)	29 (47 %)		
BMI (kg/m^2, mean ± SD)*	27.3 (±4.1)	25.5 (±4.4)	3.057	**0.002**
ASA score [n (%)]**			2.145	0.342
ASA 1	86 (34%)	25 (40%)		
ASA 2	128 (50%)	31 (50%)		
ASA 3	42 (16%)	6 (10%)		
Comorbid diseases [n (%)]**			0.675	0.411
Presence	155 (61%)	34 (55%)		
Absence	101 (39%)	28 (45%)		
Pre-operative CEA [Median (IQR)]***	2.5 (5)	0.75 (7)	–2.314	**0.021**
Pre-operative CA19-9 [Median (IQR)]***	9 (14)	0.6 (24)	–1.594	0.111

BMI, body mass index; ASA, American Society of Anesthesiologists; CEA, carcinoembryonic antigen; CA, carbohydrate antigen; IQR, Inter Quantile Range; SD, standard deviation. Significant values were presented in bold letters.

*Student's *T*-Test, ***Chi*-Square Test, ***Mann-Whitney U Test.

shorter disease-free survival (DFS) [13]. In our study, we aimed to compare patients who underwent emergent colon surgery with elective colon cancer surgery cases in the same period in terms of postoperative complications and long-term oncological outcomes.

Materials and Methods

Patient Selection

The data of all patients who underwent surgery for colonic adenocarcinoma at Hospital's General Surgery Clinic between January 2018 and December 2021 were analyzed retrospectively. Emergency and elective cases that underwent surgery due to colon adenocarcinoma were included in the study. Study exclusion criteria were:

- Pathological results other than colonic adenocarcinoma.
- Patients under the age of 18 years.
- Patients who underwent diversion only due to the critical condition.
- Patients with missing data.
- Patients with multiple malignancies.

Also, patients with rectal cancer were excluded from the study because neoadjuvant treatment had a positive effect on survival, and in some emergent cases, not being able to receive neoadjuvant treatment due to urgent surgical intervention would disrupt the balance of the study.

Emergency surgeries were defined as follows:

1- Emergent surgery due to bowel obstruction.

2- Bleeding or perforation caused by colonic adenocarcinoma that requires immediate surgery.

3- Invasion and fistulisation of extracolonic organs such as the bladder that requires emergent surgical intervention.

Data Collection

Demographic data (age, gender), body mass index (BMI), presence of comorbid disease, American Society of Anesthesiologists (ASA) score, postoperative hospital stay, preoperative carcinoembryonic antigen (CEA) and carbohydrate antigen (CA) 19-9 levels, tumor localization, operation type, postoperative complications, Stage T, Stage N, Stage M, and Pathological stages according to the American Joint Committee on Cancer (AJCC) cancer staging manual 8th edition [14], lymphovascular invasion, perineural invasion, harvested lymph nodes, and tumor positive lymph node results were recorded. If any chronic disease were present, such as diabetes, cardiovascular disease, neurological disease, immunologic disease, etc., comorbid diseases were counted as 'Presence'. We analyzed the OS and DFS of two groups. OS was the length of time from the surgery until death from any cause. DFS was the length of time after surgery that patient has no signs of disease recurrence or distant metastasis.

Statistical Analysis

The statistical analysis was conducted using SPSS version 24.0, developed by Spss Inc., IBM, in Chicago, IL, USA. The data were reported in terms of the mean ± standard deviation (SD), median, and Inter Quantile Range (IQR). The categorical data were summarized using frequency counts and percentages to describe the distribution of variables between the groups. The proportions or frequencies between the two groups were compared with χ^2 test or Fisher's exact test when more than 20% of cells have expected frequencies less than. The Kolmogorov-Smirnov test was used to analyze normal or non-parametric distribution. Differences in

Table 2. Pathological outcomes in both groups.

N: 318	Elective (N: 256)	Emergent (N: 62)	z/χ^2	p
Tumor localization [n (%)]**				0.827
Right colon	112 (44%)	23 (37%)		
Transverse colon	19 (7%)	6 (10%)		
Left colon	31 (12%)	10 (16%)		
Sigmoid colon	84 (33%)	22 (35%)		
Rectosigmoid junction	8 (3%)	1 (2%)		
Syncrone	2 (0.8%)	0 (0%)		
Operation [n (%)]*			3.095	0.797
Right hemicolectomy	95 (37%)	27 (44%)		
Segmenter colectomy	21 (8%)	3 (5%)		
Left hemicolectomy	27 (11%)	9 (15%)		
Anterior resection	109 (43%)	22 (35%)		
Subtotal colectomy	4 (2%)	1 (2%)		
Syncrone metastazectomy [n (%)]*	28 (11%)	4 (6%)	1.110	0.292
Post-operative complications [n (%)]*	37 (14%)	7 (11%)	0.419	0.517
Hospital stay (days) [Median (IQR)]***	5 (2)	5 (2)	0.229	0.819
Stage T [n (%)]**				**0.003**
T1	8 (3%)	0 (0%)		
T2	13 (5%)	3 (5%)		
T3	150 (59%)	23 (37%)		
T4	85 (33%)	36 (58%)		
Stage N [n (%)]*			1.506	0.459
N0	134 (52%)	27 (44%)		
N1	75 (29%)	21 (34%)		
N2	47 (18%)	14 (23%)		
Stage M [n (%)]*			0.030	0.863
M0	221 (86%)	53 (85%)		
M1	35 (14%)	9 (15%)		
Pathological stage [n (%)]*			0.698	0.869
Stage I	19 (7%)	3 (5%)		
Stage II	108 (42%)	25 (40%)		
Stage III	95 (37%)	25 (40%)		
Stage IV	34 (14%)	9 (15%)		
Lymphovascular invasion [n (%)]*	178 (70%)	48 (78%)	1.510	0.219
Neural invasion [n (%)]*	87 (34%)	26 (42%)	1.377	0.240
Harvested lymph nodes [Median (IQR)]***	18 (12)	17 (19)	0.425	0.671
Tumor positive lymph nodes [Median (IQR)]***	0 (3)	1 (3)	0.675	0.500

IQR, Inter Quantile Range. Significant values were presented in bold letters.

**Chi*-Square Test, **Fisher's Exact Test, ***Mann-Whitney U Test.

continuous variables were assessed using the Student's T-test for normally distributed values and the Mann-Whitney-U test for non-parametric values. The survival curves were assessed using the Kaplan-Meier method and compared using the log-rank test. Univariate and multivariate Cox proportional hazard models were used to identify prognostic factors.

Results

Patient Characteristics

A total of 318 patients were eligible for the study. Patients were divided into two groups: Elective and Emergent. While 62 of the patients underwent urgent surgery, the remaining 256 had elective procedures. The baseline characteristics of the two groups are summarized in Table 1. The mean age was 62.6 $\pm$ 11.5 years for the elective surgery group, with 145 male patients (57%) and 111 female patients (43%). The mean age for the emergent surgery group was 63.98 $\pm$ 14.3 years, with 33 male patients (53%) and

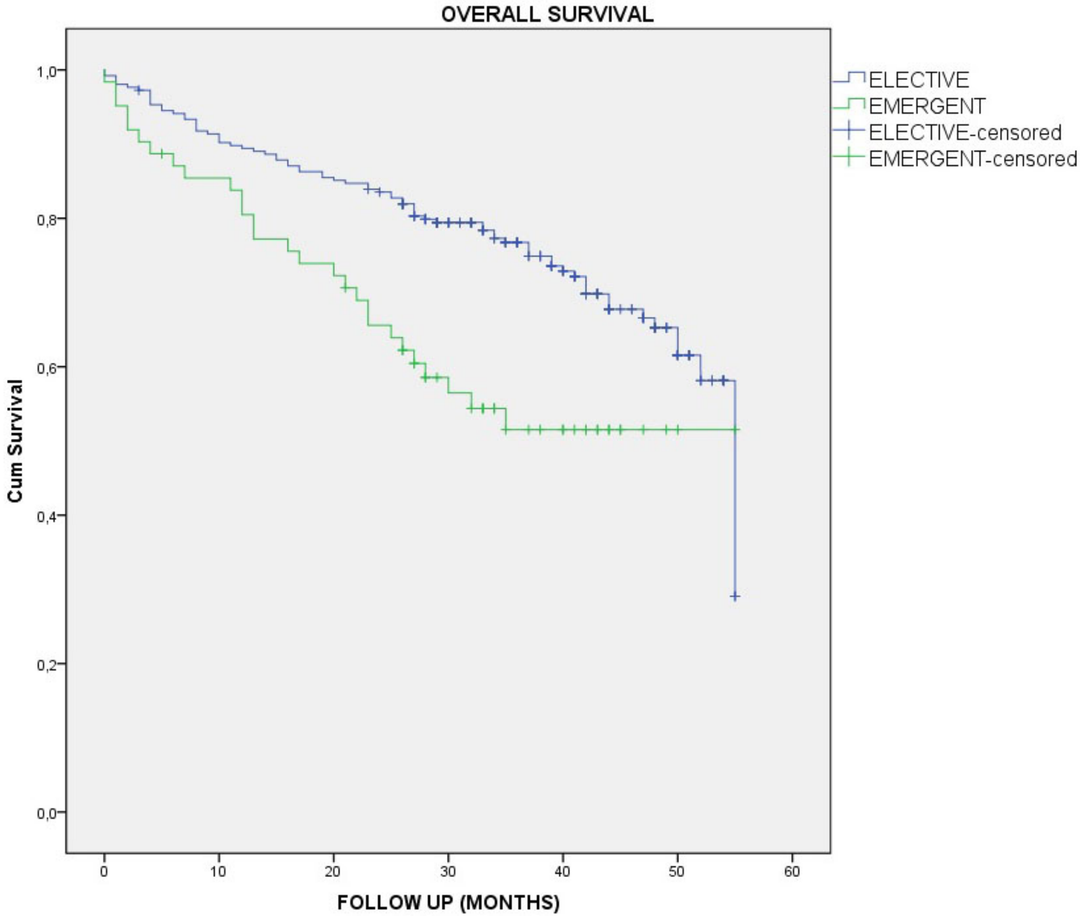

Fig. 1. Overall survival in emergent and elective colon surgery (log-rank $p = 0.002$).

29 female patients (47%). No statistical differences were observed between groups regarding age, sex, ASA Score, cormorbid diseases, and CA19-9 levels ($p > 0.05$). However, the median levels of BMI and pre-operative CEA were significantly different between the groups ($p = 0.002$ and $p = 0.021$, respectively).

Operative and Pathological Outcomes

Comparisons were made between the groups in terms of tumor localization, operation type, hospital stay, postoperative complications, and pathological data (Table 2). There was no statistical difference in tumor localization, operation type, synchronized metastasectomy, postoperative complications, or hospital stay. In the comparison of pathological data, there was no statistical difference between the groups in stage N, stage M, Pathological stage, lymphovascular invasion, neural invasion, collected lymph node, and tumor-positive lymph node data, while there was a statistically significant difference in stage T ($p = 0.003$).

Survival Analysis

OS at 50 months was 62% following elective surgery compared with 51% in those who presented as an emergency ($p = 0.002$, Fig. 1). Table 3 demonstrates univariate and Multivariate Survival Analysis. Stage N (N0 vs. N+), stage M, tumor diameter, neural invasion, and emergent surgery status are found to be independent poor prognostic factors for OS. While lymphovascular invasion was found to be associated with OS in univariate analyses, it was found to be unrelated to OS in multivariate analyses.

Disease-Free Survival

DFS at 50 months was 59% following elective surgery compared with 43% in those who presented as an emergency ($p = 0.202$, Fig. 2). Stage N, stage M, tumor diameter, neural invasion, and emergent surgery status are related to DFS according to univariate and Multivariate Survival Analysis with a 95% confidence interval (Table 4). While lymphovascular invasion was found to be associated with DFS in univariate analyses, it was found to be unrelated to DFS in multivariate analyses.

Discussion

This study was designed to observe whether there is a difference in OS and DFS between emergent and elective colon surgery. In our study, 62 out of 318 (19.5%) patients underwent emergent surgery. In the study of Xu *et al.* [8], which included 214,174 cases in the National Cancer Database be-

Table 3. Univariate and multivariate overall survival analysis for colon cancer.

N: 318	Univariate analysis*			Multivariate analysis*		
	HR	95% CI	*p*	HR	95% CI	*p*
Gender	0.910	0.684–1.209	0.514			
Age	1.012	0.995–1.030	0.159			
Comorbid diseases	1.096	0.738–1.627	0.650			
Tumor localization	0.792	0.541–1.032	0.857			
Operation type	0.976	0.612–1.293	0.125			
Complication	1.299	0.790–2.138	0.303			
Stage T (T1–T2 vs. T3–T4)	1.193	0.579–2.458	0.632			
Stage N (N0 vs. N+)	2.215	1.480–3.316	**<0.001**	1.612	1.021–2.543	**0.040**
Stage M	2.712	1.755–4.190	**<0.001**	1.979	1.248–3.137	**0.004**
Tumor diameter	1.062	1.037–1.081	**<0.001**	1.068	1.043–1.094	**<0.001**
Lymphovascular invasion	1.828	1.138–2.936	**0.013**	1.232	0.716–2.139	0.451
Neural invasion	2.217	1.499–3.280	**<0.001**	1.518	1.098–2.335	**0.033**
Emergent surgery	1.970	1.273–3.047	**0.002**	1.790	1.142–2.807	**0.011**

HR, hazard ratio; CI, confidence interval. Significant values were presented in bold letters.
*Cox regression analysis.

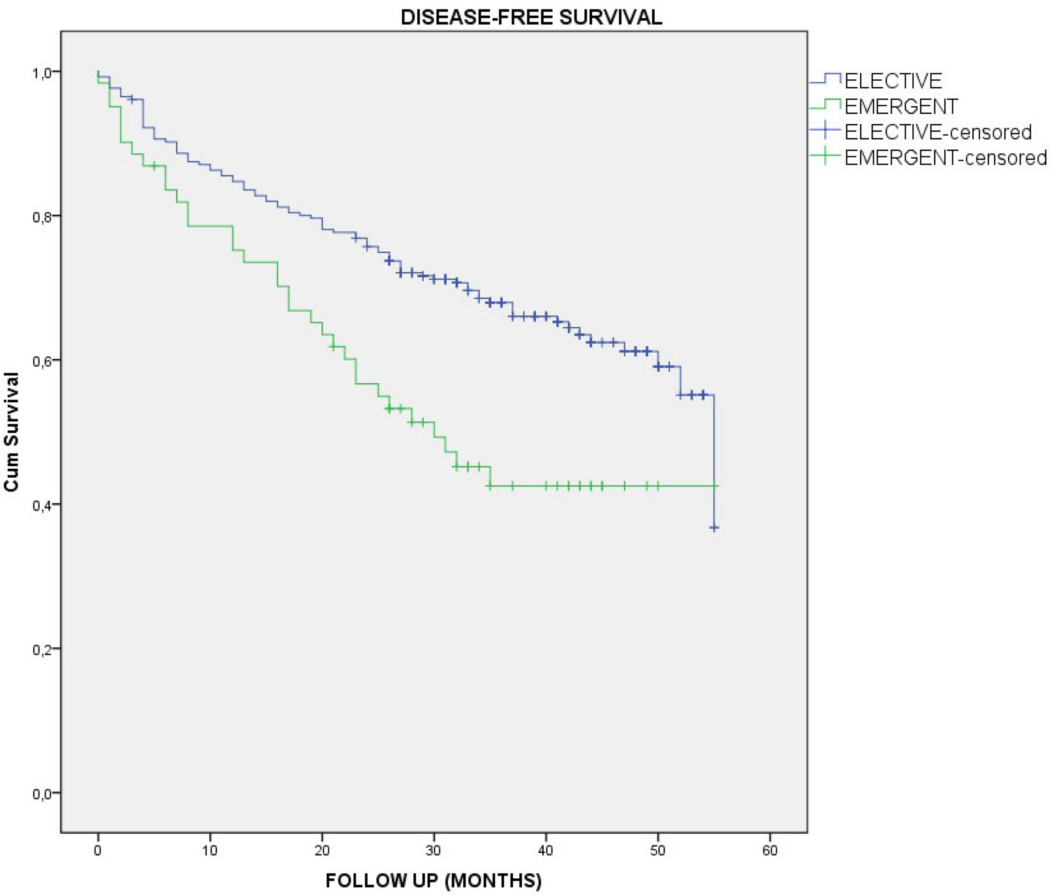

Fig. 2. Disease-free survival in both groups (Log-rank *p* = 0.202).

tween 2006 and 2012, this rate was seen as 30.3%. In other single-center studies in the literature with similar concerns, this rate ranged between 11% and 20%, similar to our study [6,7,15,16].

To analyze OS and DFS outcomes accurately in colon cancer patients undergoing elective or emergent surgery, it is important to have consistent external variables to avoid possible limitations of bias. In our study, while demographic characteristics were similar between the patient groups, a

Table 4. Univariate and multivariate disease-free survival analysis for colon cancer.

N: 318	*Univariate analysis			*Multivariate analysis		
	HR	95% CI	*p*	HR	95% CI	*p*
Gender	0.905	0.698–1.174	0.454			
Age	1.012	0.996–1.028	0.138			
Comorbid diseases	1.081	0.751–1.556	0.674			
Tumor localization	0.844	0.621–1.240	0.755			
Operation type	0.835	0.572–1.168	0.192			
Complication	1.151	0.712–1.860	0.565			
Stage T (T1–T2 vs. T3–T4)	1.241	0.606–2.542	0.555			
Stage N (N0 vs. N+)	1.483	1.232–1.784	**<0.001**	1.245	1.008–1.538	**0.042**
Stage M	2.683	1.773–4.360	**<0.001**	1.945	1.253–3.019	**0.003**
Tumor diameter	1.059	1.036–1.064	**<0.001**	1.067	1.043–1.092	**<0.001**
Lymphovascular invasion	2.016	1.296–3.137	**0.002**	1.400	0.847–2.314	0.190
Neural invasion	2.093	1.461–2.998	**<0.001**	1.516	1.015–2.265	**0.042**
Emergent surgery	1.897	1.271–2.832	**0.002**	1.669	1.099–2.534	**0.016**

HR, hazard ratio; CI, confidence interval. Significant values were presented in bold letters.

*Cox regression analysis.

difference was observed only in the T stage in terms of pathological characteristics. The reason for this difference was that there were no T1 patients who underwent emergent surgery. However, in statistical evaluation, it was observed that the T stage was ineffective in terms of OS and DFS in univariate analyses. In addition, since there was no statistical difference in AJCC staging between the groups and this staging was more important in evaluating OS and DFS, it was thought that this difference in the T stage would not create bias between the groups.

One of the main concerns in emergent colon cancer surgery is the implementation of adequate oncological surgery. Studies on this subject have contradictory results. While some state that insufficient oncological resection is performed in emergent colon surgery [7,17,18]. Others have demonstrated that in emergent surgical situations, adequate lymph node excision is performed in both elective and emergent situations in terms of oncological principles [6,19]. Since lymph node involvement is the strongest prognostic factor in colon cancer, it serves as the most important selection criterion for adjuvant chemotherapy [20,21]. The number of lymph nodes surgically removed and evaluated pathologically affects staging accuracy and OS [22,23]. For accurate staging, at least 12 examined lymph nodes per patient are recommended [24]. In our study, in accordance with these principles, a median of 18 lymph nodes was excised in the elective surgery group, while a median of 17 lymph nodes was excised in the emergent surgery group, thus achieving accurate staging and increasing the efficiency of comparison results between groups.

Although the patient groups that underwent emergent colon cancer and elective surgery in our study had similar characteristics, the worse long-term outcomes of the emergent surgery group may be due to various reasons. There is evidence that systemic inflammation in the perioperative period affects the behavior of tumor cells remaining after oncological resection, increasing the likelihood of recurrence and metastatic disease [25,26].

Ogawa *et al*. [15] found that survival was worse in patients who underwent emergent surgery, although they used propensity score matching to prevent possible bias due to a statistically significant difference between emergent and elective surgery groups. Antony *et al*. [27] applied propensity score matching for the same reason. While OS and DFS were worse in the emergent group, OS and DFS were found to be similar when compared with the propensity score-matched emergent surgery group.

It is already known that the nodal and metastatic status of colon cancer are prognostically important [4,5]. There is limited data regarding tumor diameter, but in a study by Maeda *et al*. [28], they found that tumor diameter over 4 cm was associated with recurrence in stage 2 colon cancers. In our study, similar to these findings, tumor diameter was found to be associated with OS and DFS. Tumor diameter should not be confused with stage T because Stage T refers to the depth of the tumor in the colon layers, while tumor diameter is the length of the longest axe of the tumor. Positivity of neural invasion and lymphovascular invasion are considered poor prognostic factors in stage II and III colon cancers [29]. It has been shown to reduce relapse-free survival. In our study, it was once again confirmed that neural invasion and lymphovascular invasion are associated with poor OS and DFS. Based on this information, we conclude that it may be beneficial to apply more aggressive treatment protocols in cases where the tumor diameter is large, there is positive neural invasion and lymphovascular invasion, or in cases where emergent surgery is applied. Conducting prospective studies in this direction may be beneficial in terms of these decreased survival rates.

Obesity and overweight were well-described risk factors for CRC development. Study showed a significant relationship between increased body weight and CRC diagnosis [30]. However, after the diagnosis, weight loss or being underweight might be a reflection of disease progression. Shahjehan *et al*. [31] found in their large-scale study that being underweight was a poor prognostic factor for CRC. Moreover, they argued that in some stages, obesity might be an advantage in long-term outcomes. Maskarinec *et al*. [32] conducted a multiethnic study investigating excess body weight and colorectal cancer survival. They also found little evidence of an adverse effect of excess body weight on CRC-specific survival. Our study was not solely focused on the relation between BMI and survival. Nonetheless, the results supported the existing literature.

It is known in the literature that colon cancer-specific specialization in hospitals and the experience of the surgeon affect survival in colon cancer resection [33,34]. In our study all operations were performed or supervised by experienced surgeons of a tertiary care center. Despite this, based on the results obtained, we observe that emergent surgery in colon cancer negatively affects survival.

The complex relationship between gut microbiota and CRC still remains unclear. Recent findings indicate that alterations in the complex microbiota caused by problems, such as infections or inflammation, may significantly impact these outcomes [35]. Although emergent surgery can cause considerable physiological stress, the subsequent consequences of complications, namely on the microbiota, may intensify immunological dysfunction, result in persistent inflammation, and eventually worsen long-term survival outcomes [36,37]. Hence, it is crucial to recognize and alleviate the disruption of microbiota that occurs as a result of problems since this might significantly improve the results for these patients.

There are some limitations of this study. The first is that its retrospective design might lead to some selection biases. The second is that the study was conducted in a single center, which might limit the generalizability of findings. Finally, the absence of adjuvant therapy follow-up might affect the outcomes.

Conclusions

DFS and OS rates were higher in patients who underwent elective resection for colon cancer than in patients who underwent emergent surgery. Emergent resection is associated with worse long-term outcomes, and it would be beneficial to raise awareness to reduce emergency admissions and increase the application of screening tests.

Availability of Data and Materials

The datasets used or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

HY: the concept and design of the study, data acquisition, writing-original draft, data curation; ACE: formal analysis of results, software, supervision, and validation; FV: formal analysis of results, writing-original draft, investigation; CY: Data curation, project administration, supervision, validation, writing-review & editing. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Marmara University Scientific Research Ethics Committee by date 22 April 2024 with approval number “09.2024.449”. During the study all procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, the necessity for written informed consent was waived by the Marmara University Scientific Research Ethics Committee.

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Conflict of Interest

The authors declare no conflict of interest.

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