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Original article

Risk Factors for Severe Postoperative Complications after Oncologic Right Colectomy

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ABSTRACT

This study aims to examine the possible risk factors for severe postoperative sequelae following oncologic right colectomy. This retrospective analysis included all consecutive patients with right colon cancer who had right colectomy in our department from 1st Jan 2022 to 31st Dec 2023. The Clavien-Dindo grading system was employed to assess postoperative problems. Univariate and multivariate logistic regression analysis were done to look into risk variables for serious postoperative complications. Of the 21 patients, there were 10 males and 11 females, with a median age of 68 (IQR 60–78). Postoperative morbidity and mortality rates were 42.85% (9 patients) and 9.52% (2 patients), respectively. The anastomotic leak rate was 4.76% (1 patient). Severe postoperative complications (Clavien–Dindo grades III–V) were present in 3 patients (14.28%). Univariate analysis showed the following as risk factors for postoperative severe complications: Charlson score, lack of mechanical bowel preparation, level of preoperative proteins, blood transfusions, and degree of urgency (elective/emergency right colectomy). In the logistic binary regression, the Charlson score (OR = 1.932, 95% CI = 1.077–3.463, p = 0.025) and preoperative protein level (OR = 0.048, 95% CI = 0.006–0.433, p = 0.007) were found to be independent risk factors for postoperative severe complications. Severe consequences after oncologic right colectomy are linked to a low preoperative protein level and a higher Charlson comorbidity index

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INTRODUCTION

Colorectal cancer is the world's third most frequent cancer, making it a significant public health concern [1]. Several risk factors for colorectal cancer have been identified, including aging, male gender, white race, obesity, smoking, modern dietary practices (high in red and processed meat, low in fiber and vegetables, and low in calcium and dairy products), alcohol abuse, and family history [2,3]. Colorectal cancer development includes a number of biochemical pathways that are controlled by a variety of molecules and genes. Abnormal activation of the Wnt/β-catenin signaling pathway contributes to the development and progression of colorectal cancer [4]. Loss or inactivation of adenomatous polyposis coli (APC) causes constitutive stimulation of Wnt/β-catenin signaling, which is linked to colorectal cancer [5]. According to studies, molecular pathways do not work in isolation, but rather are linked, with alterations in one

leading to changes in another [6]. Understanding how signaling pathways interact is critical for the development of tailored cancer treatments.

Since roughly one-third of all colorectal cancers are located in the right colon, oncologic right hemicolectomy is a popular surgical procedure. Anastomotic fistula AL is the most dreaded complication after colorectal cancer surgery. The rate of Anastomotic fistula following right hemicolectomy with ileo-colic anastomosis is much lower than that after left colonic resection with colorectal anastomosis. Following right colon cancer resection, the incidence of Anastomotic fistula varied from 0.02 to 8.8%, whereas it ranged from 2 to 20% following left colon cancer resection [7,8,9]. On the other hand, it has been shown that the risk factors for Anastomotic fistula differ between right colonic resection with ileocolic anastomosis and left colonic resection with colorectal anastomosis [10, 11, 12, 13].

Risk factors for morbidity and mortality following oncologic right colectomy have seldom been described, and there is no way to stratify the risk of postoperative morbidity and death in individuals who have undergone this surgical surgery. Knowing the particular risk factors for postoperative morbidity and death would allow for more comprehensive postoperative monitoring in high-risk patients. Preventive measures include preparing the patient for surgery and, if feasible, treating existing risk factors such as malnutrition or anemia [14]. Diverse surgical methods, such as strengthening the anastomosis or creating a diverting stoma to reduce the effects of a leak, can be employed to avoid Anastomotic fistula in high-risk patients [15]. An rigorous postoperative follow-up might allow for the early detection of an Anastomotic fistula or other postoperative complication, and hence the fast commencement of therapy.

The purpose of this study was to identify the risk variables associated with severe complications following an oncologic right colectomy

METHODS

Study design

from 1st January 2022 to 31st December 2023., all sequential patients who received curative intent oncologic right colectomy at Department of General Surgery, National Cancer Institute Misurata, Libya, were retrospectively analyzed. The surgical method used was a normal right colectomy with D2 lymphadenectomy. Both elective and emergency surgical procedures were included. Patients undergoing simple ileostomy, digestive bypass, or those under the age of 18 were excluded from the research. Data was selected and extracted from patient records as well as an electronic database.

Examined parameters

Prior to patient discharge, data on demographics, preoperative, surgical, and short-term outcome postoperative were recorded. The patient's demographic information (gender, age), use of tobacco and alcohol, medical comorbidities (Charlson comorbidities index), preoperative data (ASA score, serum hemoglobin, serum creatinine), preoperative nutritional status (serum total proteins, serum albumin, obesity defined as body mass index > 30), surgical details (tumor location, type of resection, type of anastomosis, hand-sewn vs. stapled anastomosis, perioperative transfusion), and postoperative information (duration of hospital stay, wound infection, anastomotic leak, reintervention, admission in the ICU, Clostridium difficile infection, noninfectious complications) were examined as potential risk factors. Tumor size and features, resection margins, the number of lymph nodes implicated and analyzed, and TNM pathological staging are all examples of pathological outcomes.

Postoperative morbidity was defined as any problem that developed within 30 days following surgery or during the hospital stay. When there were obvious indications of inflammation on the wound edge or purulent discharge coming from the site, wound infections were detected. Patients were followed up on for both infectious and noninfectious problems prior to being released from the hospital. All patients' complications were documented using the Clavien-Dindo classification [16]. According to the Clavien-Dindo classification, postoperative complications were considered serious when they were categorized as grade III (requiring surgical, endoscopic, or radiological intervention), grade IV (life-threatening condition requiring IC/ICU treatment), or grade V (patient death). Particular attention was paid to examining the existence of Anastomotic fistula in the aftermath of surgery. According to the International Study Group of Rectal Cancer, anastomotic fistula can be diagnosed in three ways: (1) clinically, with evidence of extravasation of gas or bowel content through a wound or drain; (2) radiologically, by computerized tomography, with the presence of intra-abdominal collection adjacent to the anastomosis; or (3) intraoperatively [17].

Statistical analysis

Each result was shown as a proportion or as the median and interquartile range (IQR). The Student t-test or (for non-parametric distribution) was used to evaluate bivariate comparisons for continuous variables, while the Chi-square test

was used for categorical data. The Clavien-Dindo classification was utilized to determine the parameters linked to severe complications by the application of logistic binary regression analysis. Regression model potential variables were chosen by considering bivariate connections ($p < 0.10$). A p-value of less than 0.05 on both sides was deemed significant. The SPSS software was used for statistical analyses.

RESULTS

Patient characteristics

Among 21 patients who underwent an oncologic right colectomy, there were 10 men (47.62%) and 11 women (52.38%), with a median age of 68 (IQR 60–78). The most frequent comorbidities were hypertension in 11 patients (52.38%) and diabetes mellitus in 4 patients (19.04%). Obesity (body mass index (BMI) > 30) was present in 3 patients (14.28%). The median Charlson comorbidity score was 5 (IQR 4–7). The majority of the patients had an ASA 3 score (71.42%). Preoperative lab values were hemoglobin 10.5 (IQR 9.2–11.6) g/dL, blood urea nitrogen (BUN) 36 (IQR 27–43) mg/dL, creatinine 0.8 (0.7–1) mg/dL, total proteins 6.6 (IQR 6.2–7.3) g/dL, carcinoembryonic antigen (CEA) 5.10 (IQR 2.66–14.86), and CA 19–9 13.37 (IQR 4.21–72.62).

Tumor

The sites of right colon cancer were cecum in 10 patients (47.61%), ascending colon in 5 patients (23.81%), and the hepatic angle and transverse colon in 6 patients (28.57%) as shown in Figure 1. four patients (19.05%) in the group undergoing emergency surgery had a bowel obstruction. Most of the patients had T3 stage (71.42%). The median lymph node retrieval was 16 (IQR 11–26).

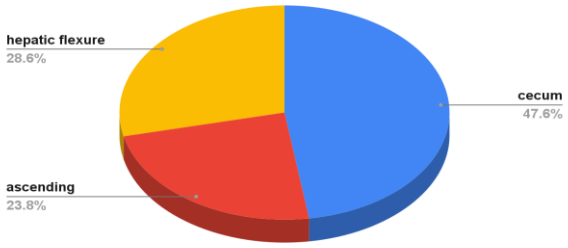

Figure 1. Distribution of patients according to the site of tumor

According to the TNM classification, there were 2 patients (9.52%) with stage I, 8 patients (38.1%) with stage II, 9 patients (42.85%) with stage III, and 2 patients (9.52%) with stage IV as shown in Figure 2.

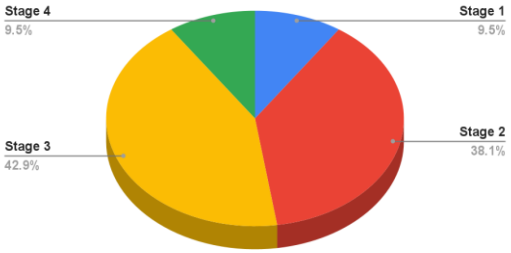

Figure 2. Distribution of patients according to stage of tumor

Surgical Procedures

For every patient undergoing elective surgery and anastomosis, mechanical bowel preparation was used. The right colectomy was performed electively in 17 patients (81%) and as an emergency operation in 4 patients (19.04%). A right colectomy with ileocolonic anastomosis was performed in all elective cases while stoma was used more often ($p = 0.001$) during the emergency surgeries (4 patients, 19.04%) compared to the elective cases (1 patient, 4.76%).

Postoperative Complications and Outcomes

Most of the patients had no complications (12 patients, 57.14%), while postoperative complications were recorded in 9 patients (42.85%). A detailed list of postoperative complications is described in (Table 1). Surgical complications

appeared in 4 patients (19.04%) and medical complications in 6 patients (28.57%). One patient had both surgical and medical complications. Anastomotic fistula was diagnosed in one patient (4.76%), one of whom operated previously as an urgent right hemicolectomy and then required surgical reintervention. Out of 2 patients with diarrhea, one patient was diagnosed with Clostridioides difficile infection. 11 patients (52.38%) received blood transfusions. The postoperative mortality rate was 9.52% (2 patients). The mortality rate was 25% (1 patient) in the emergency group, compared with 5.88% (1 patient) in the median length of postoperative hospital stay was 12 (IQR 10–15) days.

Table 1. Postoperative complications according to Clavien–Dindo grading.

Postoperative Complications	Mild Complications No. of Complications (%) n = 17	Severe Complications No. of Complications (%) n = 3
Surgical complications (n = 4)		
Wound complications	2 (11.76 %)	0
Anastomotic fistula	0	1 (25 %)
Intra-abdominal bleeding	0	0
Gastric bleeding	0	0
Partial bowel necrosis	0	0
Small bowel obstruction	1 (5.88 %)	0
Small bowel perforation	0	0
Medical complications (n = 6)		
Neurologic complications	0	0
Pulmonary complications	1 (5.88 %)	1 (25 %)
Cardiac complications	1 (5.88 %)	1 (25 %)
Renal complications	1 (5.88 %)	0
Digestive complications	1 (5.88 %)	0

Uni-multivariable analysis

A trend (p = 0.086) indicates that patients who underwent emergency surgery (25%) experienced more severe postoperative problems than those who underwent elective surgery (14.5%). The effect of blood transfusion on the use was as follows: preoperative (p = 0.065), intraoperative (p = 0.061), and postoperative (p = 0.005). The postoperative blood transfusion was excluded from the multivariate analysis model, this being rather the effect and not the cause of severe complications. The factors (Table 2) that were associated with severe postoperative complications in univariate analysis (p-value < 0.1) were: Charlson comorbidity score, mechanical bowel preparation, level of preoperative proteins, blood transfusion (preoperative and intraoperative) and urgency (elective/emergency right colectomy). A lack of correlation (p > 0.05) was identified among the variables to exclude the potential issue of multicollinearity.

Table 2. Univariate analysis of prognostic factors for postoperative severe complications.

Variables	No Complications and Mild Complications n = 17	Severe Complications n = 4	*p-Value*
Male **Female**	8 (47.05%) 9 (52.94%)	2 (50%) 2 (50%)	0.445
Age	69 (59–74)	74 (66–75)	0.061
Obesity	3 (17.64%)	0	0.695
Hypertension	9 (52.94%)	2 (50%)	0.973
Diabetes mellitus	4 (23.52%)	0	0.169
Charlson score	5 (4–7)	6 (5–9)	0.05
Hemoglobin (g/dL)	10.3 (9.2–11.6)	10.2 (9.5–11.3)	0.852
BUN (mg/dL)	34 (27–43)	28 (20–44)	0.137
Creatinine (mg/dL)	0.84 (0.7–1)	0.7 (0.6–1)	0.091
Total proteins (g/dL)	6.7 (6.32–7.43)	6.1 (5.1–6.8)	0.014
Blood transfusion (units) **Preoperative** **Intraoperative** **Postoperative**	1 (0–2) 0 (0–0) 1 (0–2) 0 (0–0)	3 (0–6) 1 (0–2) 1 (0–1) 1 (0–3)	0.065 0.062 0.005

DISCUSSION

According to the current study, medical comorbidities and nutritional status are independent risk factors for the development of severe problems following oncologic right colectomy. For this reason, preoperative prehabilitation is essential to a successful outcome. Following surgery for right colon cancer, our series' death and morbidity rates matched the previously published literature's ranges, which corresponded to 9 to 14.5% for mortality and 32 to 54.3% for morbidity [18-21].

Anastomotic fistula is the most serious surgical complication, whereas surgical site infections were the most frequent postoperative sequelae. The anastomotic fistula rate (4.76%) found in this study is comparable to those previously documented in the literature, which varied from 1.2 to 6.4% [12,13,22,23].The authors came to the conclusion that anastomotic fistula happens more frequently after colo-colic and ileo-colic anastomosis than after intraperitoneal colorectal anastomosis in a study involving 1940 consecutive patients who underwent elective colonic resection with intraperitoneal anastomosis without a diverting stoma for colorectal adenocarcinoma [24]. Compared to a left colectomy that was performed on request, the right colectomy seems to carry a higher risk of Anastomotic fistula and a higher risk of surgical intervention. The distinctions in anastomosis (ileo-colic vs. colo-colic) and microbiota may account for the variance in the profile of problems following a right or left colectomy [25].

Specifically, there is a higher chance of postoperative morbidity and death following an emergency colectomy for an obstructive tumor [26-28]. When comparing emergency and elective surgery approaches, higher rate of severe postoperative complications. A right colectomy with primary anastomosis is the recommended course of action for stable patients with blockage from right-sided colon cancer, whereas a right colectomy with terminal ileostomy ought to be the operation of choice for unstable individuals [29]. If circumstances are not ideal, ileostomy following a right colectomy is advised. When comparing the outcomes of emergent vs elective surgery for patients with colorectal cancer, Bayar et al. discovered that the group undergoing emergent surgery experienced a higher frequency of postoperative problems [30]. Upon evaluating the patients' other conditions, it was found that the emerging group had a much greater rate of comorbid conditions. The inability to regulate the condition of comorbidities in patients having emergency surgery might be one of the causes of this outcome. Patients in the emergency surgery group had longer hospital stays, were in at an advanced stage, and had greater rates of postoperative complications such as evisceration, anastomosis fistula, and surgical site infections.

The impact of the ileo-colic anastomosis's technical aspects in the development of fistula risk was thoroughly studied. There were no differences in anastomotic fistula between stapled and hand-sewn anastomosis in colorectal surgery, according to two meta-analyses [23,31]. Nonetheless, data suggests that the stapled method increases the probability of a fistula that is clinically significant [9]. A subsequent cohort research that revealed a 5.4% versus 2.4% rate of Anastomotic fistula in the stapled and handsewn groups ($p = 0.004$) further corroborated this conclusion. Multivariable analysis, which showed a twofold increase in Anastomotic fistula for the stapled approach, corroborated this difference [32].

One major risk factor for colorectal cancer is age. It was discovered that in large case series, it peaked in the seventh decade [33, 34]. The median age of patients undergoing surgery in our research was 68 years old. In comparison to individuals who experienced moderate difficulties or no issues at all, those who experienced severe postoperative complications were older (74 vs. 69). Moreover, a higher Charlson score was seen in our cohort of patients who experienced severe postoperative sequelae. This result implies that comorbidities and advanced age contribute to a higher risk of severe postoperative complications. Higher Charlson comorbidity index was found to be an independent predictor of postoperative anastomotic fistula (HR 4.91, 95% CI 2.23–10.85, $p < 0.001$) in a recent analysis of 593 instances of right-sided colon cancer resections [35]. Bakker et al. found that older age, high ASA grade, high Charlson score, and emergency surgery are independent risk factors for death after anastomotic fistula [13]. According to this study, the risk of dying from Anastomotic fistula after a right colectomy was double that of a left colectomy. In contrast to elective surgery, a number of additional studies have shown increased rates of morbidity and death in emergency colorectal surgery [36,37]. The reasons for this discrepancy included the comorbidities of the patients as well as circumstances that enhance the danger of surgery, such as hydroelectrolytic imbalances and operating on an unprepared and blocked colon, all of which led to a rise in the rates of postoperative complications. After an elective right colectomy with ileo-colic anastomosis for cancer, the primary risk factor for anastomotic fistula appears to be the patient's poor preoperative nutritional condition. Previous studies have demonstrated a correlation between low levels of serum albumin [38] or total proteins [9] and Anastomotic fistula following a colorectal resection.

Following colorectal surgery, an effective mechanical bowel preparation (MBP) was thought to be crucial in avoiding anastomotic dehiscence and related infectious problems [39]. Compared to no intestinal preparation, retrospective data have shown that intestinal preparation with mechanical and oral antibiotics reduces surgical site infections following a

colectomy [40]. With some support from observational studies for the use of oral antibiotics alone, several meta-analyses have demonstrated the beneficial effects of preoperative oral antibiotics combined with mechanical bowel preparation to reduce the incidence of surgical-site infection and potentially that of anastomotic fistula [41]. In univariate analysis, our study revealed that individuals receiving intestinal preparation had less serious side effects. According to more recent studies, giving oral antibiotics as prophylaxis the day before colon surgery considerably lowers the risk of surgical site infections without the need for mechanical bowel preparation. As a result, this practice ought to be regularly used prior to elective colon surgery [42]. Given the low prevalence of anastomotic fistula and surgical site infection, mechanical bowel preparation combined with oral antibiotics is the recommended preoperative preparation technique for elective colectomy [43]. It is still unclear what the best bowel preparation plan is to reduce the possibility of anastomotic fistula [44].

According to a number of studies, patients with right colon cancer had a much greater prevalence of anemia upon admission than patients with left colon cancer, which increased the requirement for blood products transfusions in these patients [45, 46]. More than half of the patients in our cohort needed blood transfusions, and there was evidence to suggest a link between these procedures and serious postoperative problems. According to certain investigators, preoperative anemia of any severity was linked, on its own, to a worse prognosis for patients with colonic cancer following surgery [45,47]. This might be because preoperative anemia and severely advanced tumors are related to one another. However, anemia has also been shown to be linked to an increased incidence of anastomotic fistula, most likely as a result of poor anastomotic repair brought on by local ischemia [48]. However, it has also been demonstrated that blood transfusion negatively affects the outcomes of colorectal surgery in the short- and long-terms [49, 50]. The danger of infections near anastomoses is increased by the immune suppression brought on by blood transfusions. According to Kwon et al., in nonmetastatic colorectal cancer patients, the use of perioperative blood transfusion was independently linked to poorer overall and recurrence-free survival when there was neither mild nor severe preoperative anemia. According to their findings, there should be less blood transfusions performed during the perioperative phase in order to improve oncological outcomes [50]. Patient Blood Management (PBM), an evidence-based multimodal method for optimizing blood transfusion, was created to circumvent the lax rules around blood transfusion [49].

The retroactive nature of the study and small sample of patients must be taken into consideration as a limitation of the current investigation. The primary problem of missing data was lessened by careful data collecting from reports on operation notes and medical charts. The quantity of patients covered in this investigation is another drawback. We were able to show that lower protein levels and a higher Charlson index are independent risk factors for postoperative severe sequelae, even with a very small number of patients. Preoperative blood transfusion and the absence of mechanical bowel preparation were found to be statistically significant predictors of severe postoperative complications in the univariate analysis. However, in order to validate these results, a bigger patient sample is needed.

CONCLUSION

For colon cancer, right colectomy with ileo-colic anastomosis is still linked to a high risk of morbidity and death. According to our research, low nutritional status and a higher Charlson score are independent risk factors for serious complications that may arise after oncologic right colectomy. Staged surgical treatment, such as primary defunctioning stoma or resection without anastomosis, may be a safer alternative for high-risk individuals. An uncomplicated postoperative phase following oncologic right colectomy requires cancer prehabilitation and case selection for anastomosis/stoma.

Conflict of interest. Nil

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عوامل الخطر لمضاعفات ما بعد الجراحة الشديدة بعد استئصال القولون الأيمن للأورام

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المستخلص

تهدف هذه الدراسة إلى دراسة عوامل الخطر المحتملة لعقابيل ما بعد الجراحة الشديدة بعد استئصال القولون الأيمن للأورام. شمل هذا التحليل بأثر رجعي جميع المرضى المتتاليين المصابين بسرطان القولون الأيمن والذين خضعوا لعملية استئصال القولون الأيمن في قسمنا من 1 يناير 2022 إلى 31 ديسمبر 2023. تم استخدام نظام تصنيف Clavien-Dindo لتقييم مشاكل ما بعد الجراحة. تم إجراء تحليل الانحدار اللوجستي أحادي المتغير ومتعدد المتغيرات للنظر في متغيرات الخطر لمضاعفات ما بعد الجراحة الخطيرة. كان هناك 17 مريضا، 8 ذكور و 9 إناث، بمتوسط عمر 68 (معدل الذكاء 59-75). وكانت معدلات المراضة والوفيات بعد العملية الجراحية 35.29٪ (6 مرضى) و 11.76٪ (مريضان)، على التوالي. وكان معدل التسرب المفاغرة 5.88٪ (مريض واحد). حدثت مشاكل حادة بعد العملية الجراحية (الدرجات Clavien-Dindo من الثالث إلى الخامس (في مريضين (11.76٪). كشف التحليل أحادي المتغير عن متغيرات الخطر التالية للمضاعفات الشديدة بعد العملية الجراحية: درجة تشارلسون، عدد البروتينات قبل الجراحة، عمليات نقل الدم. في الانحدار الثنائي اللوجستي، تم الكشف عن درجة تشارلسون (OR = 1.931، 95٪-CI = 1.077-3.463، p = 0.025) ومستوى البروتين قبل الجراحة (OR = 0.049، 95٪ CI = 0.006-0.433، p = 0.007). عوامل الخطر المستقلة للعقابيل الشديدة بعد العملية الجراحية. ترتبط العواقب الوخيمة بعد استئصال القولون الأيمن للورم بانخفاض مستوى البروتين قبل الجراحة وارتفاع مؤشر الاعتلال المشترك لتشارلسون.

الكلمات الدالة. عامل الخطر، مضاعفات ما بعد الجراحة، استئصال القولون الأيمن للأورام.