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The effect of laparoscopy on the development of major complications in surgery of high-risk colorectal cancer patients

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ABSTRACT

Introduction: There are conflicting results in studies regarding the effect of laparoscopic surgery on postoperative complications in colorectal cancer patients. This study aims to evaluate the effect of laparoscopic surgery on major complications in patients undergoing surgery for colorectal cancer.

Materials and Methods: A retrospective review was conducted on 370 patients who underwent oncologic surgery for colorectal cancer at Kartal Koşuyolu High Specialization Hospital between 2013 and 2022. Patients with missing data were excluded, and a total of 257 patients were included in the study. Patients were divided into two groups based on the development of major or no complications, and clinical and pathological data were compared. The relationship between surgical method (laparoscopic vs. conventional) and complications was evaluated using multivariate Cox regression analysis.

Results: Major complications occurred in 106 of the 257 patients included in the study. The rate of major complications was found to be significantly lower in patients who underwent laparoscopic surgery (12.2% vs. 30.4%; p<0.001). In univariate analysis, conventional surgery (OR: 3.134; p<0.001), high body mass index (p=0.046), and history of Chronic Obstructive Pulmonary Disease/asthma (p=0.046) were found to be associated with major complications. In multivariate analysis, only conventional surgery was identified as an independent risk factor (OR: 2.969; p=0.002).

Conclusion: Laparoscopic surgery significantly reduces the risk of major complications in patients with colorectal cancer and can be considered a safe and effective surgical option, even in patient populations with high comorbidities.

Keywords: Clavien-Dindo classification, colorectal cancer, laparoscopic colorectal surgery, postoperative complications

Introduction

Colorectal cancer ranks as the third most common cancer globally. Advances in screening and treatment have led to steadily improving patient survival.[1] The adoption of mesocolic and mesorectal excisions via embryological plane dissection has demonstrated that survival depends not only on disease stage but also on the quality of surgical resection.[2,3]

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Since its introduction in the 1990s, laparoscopy has become integral to surgical practice, offering significant benefits such as enhanced recovery, minimal scarring, and reduced convalescence due to its minimally invasive nature. Although initially met with skepticism regarding oncological adequacy, laparoscopic surgery has now emerged as the gold standard for numerous oncological resections.[4]

The expanding role of laparoscopy has prompted extensive research into its prognostic impact and applicability. Notably, postoperative complications can delay adjuvant therapy in patients with locally advanced disease, adversely affecting survival.[5] A study by Santacruz et al.[6] demonstrated that laparoscopic procedures are less likely to cause Clavien-Dindo classification grade 3-4 complications in colon cancer patients. Initially viewed with caution, laparoscopy has proven comparable to open surgery in applicability and oncological outcomes, with growing evidence supporting its superior safety profile in terms of morbidity.[6-9]

However, as our institution is a tertiary cardiac referral center, the safety of laparoscopic colorectal surgery within a patient population characterized by high comorbidity burdens remains underexplored in the literature. This study aimed to evaluate the impact of the surgical approach on major complications in patients undergoing colorectal cancer resection at our center and to determine the safer technique for this high-risk cohort.

Materials and Methods

Study Population and Design

We conducted a retrospective analysis of 370 patients who underwent oncologic surgery for colorectal cancer at the Gastroenterology Surgery Clinic of Kartal Koşuyolu High Specialization Hospital between January 1, 2013, and December 31, 2022. All procedures were performed by board-certified surgeons with a minimum of five years of specialization. Adherence to oncological principles was maintained, with total mesorectal excision (TME) or complete mesocolic excision (CME) achieving R0 resection constituting the standard surgical technique.[3] The choice between laparoscopy and open surgery was influenced by patient factors and surgeon experience; open surgery was often preferred for ASA IV patients with high anesthetic risk due to previous abdominal surgeries or significant comorbidities.

Exclusion criteria encompassed emergency surgery (n=16), palliative procedures (n=22), R2 resections (n=14), patients undergoing HIPEC for peritoneal carcinomatosis (n=12), and those with incomplete preoperative, perioperative, pathological, or follow-up data (n=49). Consequently, 257 patients were included in the final analysis.

Inclusion Criteria

a) Patients undergoing elective surgery for histologically confirmed colon or rectal adenocarcinoma.

b) Patients who underwent R0 resection following oncological principles (TME/CME).

c) Availability of complete follow-up data and clinicopathological records.

d) Age 18 years or older.

Exclusion criteria:

a) Patients undergoing palliative or emergency surgery

b) Patients with inadequate oncological principles, such as positive surgical margins in pathology data or R2 resection

c) Patients with missing preoperative data, perioperative findings, pathological data, neoadjuvant treatment protocols, and postoperative follow-up data

d) Age under 18 years

Data Collection

Patient-related variables included age, gender, body mass index (BMI), and American Society of Anesthesiologists (ASA) score. Preoperative carcinoembryonic antigen (CEA) and CA 19-9 levels were retrieved from medical records. Tumor characteristics included location, size, differentiation, pT/pN stage, TNM stage (UICC-AJCC 8th edition),[10] lymphovascular invasion (LVI), and perineural invasion (PNI). Comorbidity data were obtained from anesthesia forms and discharge summaries.

Postoperative complications were graded according to the Clavien-Dindo classification,[11] with major complications defined as Grade III or higher. Data on complications, intensive care unit (ICU) admission, and length of stay were extracted from hospital records.

Statistical Analysis

Statistical analyses were performed using IBM® SPSS® Statistics version 25 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed with the Kolmogorov-Smirnov test. Categorical variables are presented as frequencies and percentages, and continuous variables as means ± standard deviation (SD). Group comparisons utilized the chi-square test for categorical variables and the independent t-test for continuous variables. Multivariate logistic regression analysis was employed to identify independent risk factors for major complications. A p-value <0.05 was considered statistically significant.

Ethical Approval

The study protocol received approval from the Institutional Research and Ethics Committee of the Health Sciences University Koşuyolu High Specialization Hospital (Date: 03/09/2024; No: 2024/15/902) and conducted according to Helsinki Declaration.

Results

Major complications occurred in 106 (41.2%) of the 257 patients. Comparative analysis revealed a significantly higher prevalence of asthma/COPD history in the major complication group (16.9% vs. 8.6%; p=0.042). The laparoscopic approach was less frequently utilized in patients who experienced major complications (12.2% vs. 30.4%; p<0.001). BMI was also higher in the major complication group (28.35±5.02 vs. 26.80±3.75; p=0.048). Other parameters showed no significant differences (p>0.05) (Table 1).

Comparison based on surgical approach demonstrated that ostomy formation was more common in the conventional surgery group (30.8% vs. 13.5%; p=0.009). Similarly, metastatic (M1) disease (9.5% vs. 1.6%; p=0.047) and receipt of neoadjuvant therapy (25.2% vs. 12.2%; p=0.030) were more prevalent in the conventional group. Surgical site infection (SSI) rates were significantly higher after conventional surgery (29.2% vs. 8.4%; p<0.001). Operative time was longer in the laparoscopic group (250±59 min vs. 213±69 min; p=0.024). Other variables were similarly distributed between the groups (p>0.05) (Table 2).

Univariate analysis identified conventional surgery (OR: 3.134, p<0.001), higher BMI (OR: 1.055, p=0.046), and a history of COPD/Asthma (OR: 2.171, p=0.046) as significant risk factors for major complications. These significant variables were included in a multivariate Cox regression model, which confirmed conventional surgery as an independent risk factor for major complications (OR: 2.969, 95% CI: 1.497-5.890; p=0.002). Higher BMI (OR: 1.037, p=0.194) and COPD/Asthma history (OR: 2.002, p=0.086) were not independent risk factors in the multivariate analysis (Table 3).

Discussion

This single-center retrospective study provides valuable insights into the comparative outcomes of laparoscopic versus conventional open surgery for colorectal cancer in a high-risk patient population treated at a tertiary cardiac referral center. Our findings demonstrate that laparoscopic surgery is associated with a significantly lower risk of major complications compared to open surgery, even after adjusting for potential confounders. Multivariate analysis confirmed conventional surgery as an independent predictor of major morbidity (OR: 2.969; p=0.002), underscoring the potential benefits of minimally invasive approaches in this challenging patient population.

The elevated overall rate of major complications (41.2%) in our cohort likely reflects the complex nature of our patient population, characterized by advanced age and significant comorbidities. This observation aligns with previous studies demonstrating increased surgical risk in patients with multiple comorbidities.[12] Importantly, despite this high-risk profile, laparoscopic approach emerged as a protective factor, consistent with growing evidence supporting the safety and efficacy of minimally invasive techniques in complex surgical populations.

Our results contribute to the substantial body of literature establishing laparoscopic colorectal surgery as a standard of care. Multiple randomized controlled trials and meta-analyses have demonstrated the non-inferiority of laparoscopic approaches regarding oncological outcomes while highlighting advantages in short-term recovery.[8,9,13] The landmark COST trial established the oncological safety of laparoscopy for colon cancer,[14] while more recent studies have extended these findings to rectal cancer surgery.[15] Our study strengthens this evidence base by specifically addressing outcomes in a high-comorbidity population, an area where comparative data remain limited.

Table 1. Effects of patient demographic and clinicopathological variables on the development of major complications

	Complications Absent (n:151)	Complications Present (n:106)	p†
Gender			
Male	83 (54.9%)	64 (60.3%)	0.388
Female	68 (45.0%)	42 (39.6%)	
ASA Score			
ASA I	8 (5.2%)	4 (3.7%)	0.054
ASA II	55 (36.4%)	33 (31.1%)	
ASA III	85 (56.2%)	59 (55.6%)	
ASA IV	3 (1.9%)	10 (9.4%)	
Hypertension			
No	81 (53.6%)	48 (45.2%)	0.187
Yes	70 (46.3%)	58 (54.7%)	
Coronary Artery Disease			
No	144 (95.3%)	101 (95.2%)	0.976
Yes	7 (4.6%)	5 (4.7%)	
Diabetes			
No	119 (78.8%)	73 (68.8%)	0.071
Yes	32 (21.1%)	33 (31.1%)	
COPD / Asthma			
No	138 (91.3%)	88 (83.0%)	0.042*
Yes	13 (8.6%)	18 (16.9%)	
Smoking			
No	107 (70.8%)	79 (74.5%)	0.517
Yes	44 (29.1%)	27 (25.4%)	
Localization			
Caecum	19 (12.5%)	11 (10.3%)	0.981
Ascending Colon	25 (16.5%)	19 (17.9%)	
Transverse Colon	5 (3.3%)	3 (2.8%)	
Descending Colon	14 (9.2%)	8 (7.5%)	
Sigmoid Colon	34 (22.5%)	24 (22.6%)	
Rectum	54 (35.7%)	41 (38.6%)	
Surgery			
Right Hemicolectomy	45 (29.8%)	29 (27.3%)	0.673
Extended Right Hemicolectomy	0 (0.0%)	2 (1.8%)	
Transverse Colectomy	2 (1.3%)	1 (0.9%)	
Left Hemicolectomy	14 (9.2%)	7 (6.6%)	
Anterior Resection	32 (21.1%)	21 (19.8%)	
Low Anterior Resection	45 (29.8%)	37 (34.9%)	
Abdominoperineal Resection	8 (5.2%)	6 (5.6%)	
Subtotal Colectomy	3 (1.9%)	3 (2.8%)	
Total Colectomy	2 (1.3%)	0 (0.0%)	
Ostomy			
No	116 (76.8%)	72 (67.9%)	0.113
Yes	35 (23.1%)	34 (32%)	

Table 1. Cont.

	Complications Absent (n:151)	Complications Present (n:106)	p†
Stage			
I	27 (17.8%)	11 (10.3%)	0.375
II	60 (39.7%)	49 (46.2%)	
III	53 (35.0%)	37 (34.9%)	
IV	11 (7.2%)	9 (8.4%)	
T Stage			
T1	12 (7.9%)	4 (3.7%)	0.233
T2	24 (15.8%)	11 (10.3%)	
T3	95 (62.9%)	72 (67.9%)	
T4	20 (13.2%)	19 (17.9%)	
N Stage			
N0	88 (58.2%)	63 (58.8%)	0.795
N1	42 (27.8%)	26 (24.5%)	
N2	21 (13.9%)	17 (16.0%)	
M Stage			
M0	140 (92.7%)	97 (91.5%)	0.722
M1	11 (7.2%)	9 (8.4%)	
Neoadjuvant			
No	123 (81.4%)	77 (72.6%)	0.094
Yes	28 (18.5%)	29 (27.3%)	
PNI			
No	113 (74.8%)	80 (75.4%)	0.907
Yes	38 (25.1%)	26 (24.5%)	
LVI			
No	97 (64.2%)	78 (73.5%)	0.114
Yes	54 (35.7%)	28 (26.4%)	
Grade			
Well	24 (15.8%)	14 (13.2%)	0.716
Moderate	111 (73.5%)	78 (75.4%)	
Poor	16 (10.5%)	14 (13.2%)	
Laparoscopy			
No	105 (69.5%)	93 (87.7%)	<0.001***
Yes	46 (30.4%)	13 (12.2%)	
	Mean±SD	**p‡**	
Age	61±12	63±13	0.929
BMI	26.80±3.75	28.35±5.02	0.048*
CEA	8.63±20.08	16.05±103.16	0.099
CA19.9	47.25±308.68	13.12±17.23	0.063
CA125	14.75±17.00	14.93±23.25	0.338
Operation Time (minutes)	220±65	223±72	0.288

ASA: American Society of Anesthesiology; COPD: Chronic Obstructive Pulmonary Disease; PNI: Perineural Invasion; LVI: Lymphovascular Invasion; BMI: Body Mass Index; CEA Chorioambryonic Antigen; CA: Cancer Antigen IQR: Inter Quartile Range; * p<0.05, **p<0.01, ***p<0.001; †: Chi-Square; ‡: Independent T Test.

Table 2. Patient demographic and clinicopathologic variables according to surgery type

	Conventional (n=198)	Laparoscopy (n=59)	p†
Gender			
Male	115 (58.0%)	32 (54.2%)	0.600
Female	83 (41.9%)	27 (45.7%)	
ASA Score			
ASA I	9 (4.54%)	3 ((5.08%)	0.246
ASA II	66 (33.3%)	22 (37.2%)	
ASA III	110 (55.5%)	34 (57.6%)	
ASA IV	13 (6.56%)	0 (0.0)	
Hypertension			
No	94 (47.4%)	35 (59.3%)	0.110
Yes	104 (52.5%)	24 (40.6%)	
Coronary Artery Disease			
No	172 (86.8%)	56 (94.9%)	0.086
Yes	26 (13.1%)	3 (5.08)	
Diabetes			
No	141 (71.2%)	51 (86.4%)	0.018
Yes	57 (28.7%)	8 (13.5%)	
COPD / Asthma			
No	173 (87.3%)	53 (89.8%)	0.611
Yes	25 (12.6%)	6 (10.1%)	
Smoking			
No	143 (72.2%)	43 (72.8%)	0.921
Yes	55 (27.7%)	16 (27.1%)	
Localization			
Caecum	23 (11.6%)	7 (11.8%)	0.091
Ascending Colon	32 (16.1%)	12 (20.3%)	
Transverse Colon	8 (4.0%)	0 (0.0%)	
Descending Colon	18 (9.0%)	4 (6.7%)	
Sigmoid Colon	38 (19.1%)	20 (33.8%)	
Rectum	79 (39.8%)	16 (27.1%)	
Surgery			
Right Hemicolectomy	55 (27.7%)	19 (32.2%)	0.108
Extended Right Hemicolectomy	2 (1.0%)	0 (0.0%)	
Transverse Colectomy	3 (1.5%)	0 (0.0%)	
Left Hemicolectomy	17 (8.5%)	4 (6.77%)	
Anterior Resection	33 (16.6%)	20 (33.8%)	
Low Anterior Resection	68 (34.3%)	14 (23.7%)	
Abdominoperineal Resection	12 (6.0%)	2 (3.3%)	
Subtotal Colectomy	6 (3.0%)	0 (0.0%)	
Total Colectomy	2 (1.0%)	0 (0.0%)	
Ostomy			
No	137 (69.1%)	51 (86.4%)	0.009**
Yes	61 (30.8%)	8 (13.5%)	

Table 2. Cont.

	Conventional (n=198)	Laparoscopy (n=59)	p†
Stage			
I	29 (14.6%)	9 (15.2%)	0.256
II	83 (41.9%)	26 (44.0%)	
III	67 (33.8%)	23 (38.9%)	
IV	19 (9.5%)	1 (1.6%)	
T Stage			
T1	12 (6%)	4 (6.7%)	0.969
T2	26 (13.1%)	9 (15.2%)	
T3	130 (65.6%)	37 (64.7%)	
T4	30 (15.1%)	9 (25.2%)	
N Stage			
N0	118 (59.5%)	33 (55.9%)	0.836
N1	52 (26.2%)	16 (27.1%)	
N2	28 (14.1%)	10 (16.9%)	
M Stage			
M0	179 (90.4%)	58 (98.3%)	0.047*
M1	19 (9.5%)	1 (1.6%)	
Neoadjuvant			
No	148 (74.7%)	52 (26.2%)	0.030*
Yes	50 (25.2%)	7 (11.8%)	
PNI			
No	152 (76.7%)	41 (69.4%)	0.257
Yes	46 (23.2%)	18 (30.5%)	
LVI			
No	140 (70.7%)	35 (59.3%)	0.100
Yes	58 (29.2%)	24 (40.6%)	
Grade			
Well	25 (12.6%)	13 (22.0%)	0.201
Moderate	149 (75.2%)	40 (67.7%)	
Poor	24 (12.1%)	6 (10.1%)	
Chylous Ascites			
No	196 (99.0%)	58 (98.3%)	0.667
Yes	2 (1.0%)	1 (1.6%)	
Pneumonia			
No	195 (98.5%)	59 (100%)	0.342
Yes	3 (1.5%)	0 (0.0%)	
Acute Kidney Failure			
No	196 (99.0%)	59 (100%)	0.438
Yes	2 (1.0%)	0 (0.0%)	
AMIO			
No	182 (91.9%)	57 (96.6%)	0.215
Yes	16 (8.1%)	2 (3.4%)	

Table 2. Cont.

	Conventional (n=198)	Laparoscopy (n=59)	p†
Anastomosis Leakage			
No	185 (93.4%)	57 (96.6%)	0.361
Yes	13 (6.6%)	2 (3.4%)	
Surgical Site Infection			
No	140 (70.7%)	54 (91.5%)	0.001***
Yes	58 (29.2%)	5 (8.4%)	
	Mean±SD	**p ‡**	
Age	63±12	58±13	0.648
BMI	27.49±4.31	28.71±5.36	0.080
CEA	12.73±76.94	8.18±15.62	0.420
CA19.9	36.66±269.89	11.42±13.29	0.209
CA 125	15.32±21.35	13.15±13.19	0.127
Operation Time (minutes)	213±69	250±59	0.024*

ASA: American Society of Anesthesiology, COPD: Chronic Obstructive Pulmonary Disease, PNI: Perineural Invasion, LVI: Lymphovascular Invasion,AMIO: Acute Mechanic Intestinal Obstruction, BMI: Body Mass Index; CEA Chorioambryonic Antigen; CA: Cancer Antigen IQR: Inter Quartile Range; * p<0.05, **p<0.01, ***p<0.001 †: Chi-Square, ‡: Independent T Test.

Table 3. Prognostic factors for major complication, identified by multivariate Cox regression analysis

	Univariate			Multivariate		
Prognostic factors	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Conventional Surgery	3.134	1.594-6.161	<0.001***	2.969	1.497-5.890	0.002**
Neoadjuvant Treatment	1.654	0.915-2.991	0.096	-	-	-
M1 Stage	1.181	0.471-2.958	0.723	-	-	-
Ostomy Formation	1.565	0.898-2.729	0.114	-	-	-
BMI	1.055	1.001-1.112	0.046*	1.037	0.982-1.095	0.194
Surgery Time (minutes)	1.001	0.997-1.004	0.771	-	-	-
COPD / Asthma History	2.171	1.014-4.651	0.046*	2.002	0.907-4.421	0.086

BMI: Body Mass Index; COPD: Chronic Obstructive Pulmonary Disease, OR: Odds Ratio; CI: Confidence Interval, * p<0.05, **p<0.01, ***p<0.001 †: Chi-Square, ‡: Indipendent T Test.

The physiological advantages of laparoscopic surgery may explain our observed outcomes. Minimally invasive techniques are associated with reduced surgical trauma, diminished inflammatory response, and better preservation of immune function compared to open surgery.[16] Kampman et al.[17] documented superior inflammatory profiles following laparoscopic colorectal resection, correlating with reduced complication rates. This aligns with our finding of significantly lower surgical site infection rates in the laparoscopic group (8.4% vs. 29.2%; p<0.001), suggesting modulated inflammatory responses and improved tissue healing.

Cardiopulmonary complications represent a major concern in high-risk surgical populations. Our findings support previous research indicating reduced cardiopulmonary morbidity with laparoscopic approaches. Schiphorst et al.[18] demonstrated significantly fewer pulmonary complications and trends toward reduced cardiac events following laparoscopic colectomy. These advantages may be particularly relevant in patients with preexisting cardiopulmonary conditions, who comprised a substantial portion of our cohort. The minimized diaphragmatic manipulation and reduced postoperative pain associated with laparoscopy likely contribute to better pulmonary function and earlier mobilization. Currie et al.[19] also reported in a meta-analysis of 40 studies reporting on 11,516 randomized patients that laparoscopic surgery reduces complications of colorectal cancer surgery but not mortality. Another meta-analysis of 24 studies concluded that laparoscopic surgery is more beneficial than open surgery in elderly individuals with colorectal cancer and should be prioritized based on the availability of the necessary technical skills and facilities.[20]

Drews et al.[21] argue that the use of laparoscopic surgery for colorectal cancer in elderly patients with high comorbidities does not increase complications and can be strongly advocated. However, the use of minimally invasive surgery in very elderly patients with low-lying rectal carcinoma should be clarified by first examining their quality of life. Obara et al.[22] report that standard laparoscopic surgical procedures can be safely performed in colorectal cancer patients receiving hemodialysis due to comorbid renal failure. Hashida et al.[23] also reported the feasibility and safety of laparoscopic surgery in a study of 108 very elderly colorectal cancer patients aged 85 years and older. Devoto et al.[24] also reported the feasibility and safety of elective laparoscopic resection in patients with colorectal cancer aged 85 years and older. Khor et al.[25] demonstrated no significant difference in incisional hernia rates between patients undergoing laparoscopic and open colorectal cancer surgery. They reported that female gender, higher body mass index (BMI), and higher ASA increased the risk of developing an incisional hernia after major colorectal cancer resection. Our study population had higher comorbidities and older age, and laparoscopic surgery had lower morbidity compared to open surgery, and even conventional surgery was a poor prognostic factor for postoperative complications.

A meta-analysis of 24 studies, including 4,592 patients in the laparoscopic surgery group and 3,865 patients in the open surgery group, reported that laparoscopic surgery significantly reduced estimated blood loss, length of hospital stay, and postoperative mortality and morbidity compared with open surgery.[26] Although laparoscopic surgery in our study was found to have a longer operative time compared with open surgery (250 min vs. 213 min; p=0.024), this difference did not have a significant negative impact on clinical outcomes. Furthermore, the literature suggests that operative times shorten with increasing surgical experience.[8,9] Wound infection and the need for ostomy were found to be less common in patients undergoing laparoscopic surgery in our study. The longer operative times observed in our laparoscopic group (250±59 min vs. 213±69 min; p=0.024) are consistent with previous reports and reflect the technical demands of minimally invasive surgery. However, this did not translate to increased complications, supporting the concept that surgical duration alone may not determine outcomes when procedures are performed by experienced surgeons.[27]] The learning curve phenomenon in laparoscopic colorectal surgery is well-documented, with operative times typically decreasing as surgical teams gain experience.[28]

Our multivariate analysis revealed that while high BMI and COPD/asthma history were significant in univariate analysis, they lost independent significance when surgical approach was considered. This suggests that the benefits of laparoscopy may be particularly pronounced in these high-risk subgroups. Previous studies have specifically addressed laparoscopic outcomes in obese patients and those with respiratory comorbidities,[28] generally reporting maintained advantages despite technical challenges.

The concentration of ASA IV patients in the conventional surgery group represents an important limitation and potential source of selection bias. This reflects real-world clinical practice where surgeons may opt for open approaches in the highest-risk patients. However, the persistence of the laparoscopic advantage after multivariate adjustment suggests a genuine protective effect. Recent evidence increasingly supports the feasibility of minimally invasive surgery even in high-risk populations,[29] challenging traditional selection criteria.

Several additional limitations warrant consideration. The retrospective design introduces potential for unmeasured confounding, despite our statistical adjustments. The single-center nature limits generalizability, though it ensures consistency in surgical technique and perioperative care. Surgeon preference and evolving experience over the study period may have influenced outcomes, though all operators were beyond their learning curve. Finally, while we focused on major complications, assessment of long-term oncological outcomes and quality of life measures would provide valuable complementary information.

Our findings have important clinical implications. They suggest that laparoscopic approaches should be considered not only for standard-risk patients but also for carefully selected complex cases with significant comorbidities. Preoperative optimization remains crucial, but concerns about increased risk with minimally invasive techniques in this population may be overstated. Rather, the physiological advantages of laparoscopy may be particularly beneficial for high-risk patients.[30]

Future research directions include prospective randomized trials specifically targeting high-comorbidity populations, cost-effectiveness analyses incorporating long-term outcomes, and studies evaluating the integration of enhanced recovery protocols with minimally invasive approaches in complex patients. Additionally, research on patient-reported outcomes and quality of life measures would complement the complication-focused outcomes presented here.

Conclusion

In conclusion, our study demonstrates that laparoscopic colorectal surgery is associated with significantly reduced major complications compared to open surgery, even in a patient population with high comorbidity burden treated at a tertiary cardiac center. The laparoscopic approach emerged as an independent protective factor, suggesting its potential as the preferred option for appropriately selected patients regardless of comorbidity status. These findings support the continued expansion of minimally invasive techniques in complex surgical populations, while highlighting the need for careful patient selection and surgical expertise. Prospective studies are warranted to validate these results and further refine patient selection criteria.

Disclosures

Ethics Committee Approval: The study protocol received approval from the Institutional Research and Ethics Committee of the Health Sciences University Koşuyolu High Specialization Hospital (Date: 03/09/2024, No: 2024/15/902).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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