

Investigating the Factors Influencing Postoperative Dynamic Intestinal Obstruction Following Laparoscopic Colorectal Radical Surgery

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AIM: Colorectal cancer (CRC) primarily arises from a combination of genetic, environmental, and dietary factors. Compared to traditional open surgery, minimally invasive laparoscopic surgery offers several advantages in managing CRC. This study investigates the factors influencing dynamic intestinal obstruction following laparoscopic colorectal radical surgery.

METHODS: We collected clinical data from 218 CRC patients who underwent laparoscopic radical surgery at the People's Hospital of Xinjiang Uygur Autonomous Region, China between January 2022 and December 2023. The patients were followed up for 30 days post-surgery, and those who developed dynamic intestinal obstruction were placed in the complication group, while those who did not were included in the control group. The quality of life for all patients was assessed using Quality of Life Score (QoL) measures. The incidence of postoperative dynamic intestinal obstruction was calculated. Baseline and clinical data were collected using a standardized patient data form, and risk factors for postoperative dynamic intestinal obstruction were analyzed.

RESULTS: Postoperative evaluation revealed that 42 out of 218 patients developed dynamic intestinal obstruction, with an incidence rate of 19.27%. Univariate analysis revealed no statistically significant differences between the complication and control groups in terms of gender, age, body mass index (BMI), education level, Quality of Life Score tumor location, degree of differentiation, tumor diameter, surgery duration, presence of hypertension, history of diabetes, hyperlipidemia (HLP), smoking or alcoholism history, or postoperative abdominal infection ($p > 0.05$). Furthermore, factors such as tumor stage, preoperative hypoproteinemia, history of abdominal surgery, preoperative intestinal obstruction, and lymph node metastasis were identified as risk factors for postoperative dynamic intestinal obstruction. Logistic regression analysis further indicated that tumor stage, preoperative hypoproteinemia, history of abdominal surgery, preoperative intestinal obstruction, and presence of lymph node metastasis were all independent risk factors for dynamic intestinal obstruction after surgery (Odds Ratio (OR) > 1 , $p < 0.05$).

CONCLUSIONS: Dynamic intestinal obstruction following laparoscopic radical surgery for CRC is significantly correlated with factors such as tumor stage, preoperative hypoproteinemia, history of abdominal surgery, preoperative intestinal obstruction, and lymph node metastasis.

Keywords: Colorectal cancer; laparoscopic radical surgery; dynamic intestinal obstruction; prognostic factors

Introduction

Colorectal cancer (CRC), the third deadliest cancer globally, is known for its aggressive nature among gastrointestinal tumors, with a high incidence, challenging treatment, and poor prognosis. Each year, approximately 1.9 million CRC cases are diagnosed, accounting for 10% of all cancers worldwide [1]. Patients typically experience limited survival rates and minimal improvement in their quality of life after treatment, significantly impacting overall health and well-being [2]. The etiology of CRC is multifaceted, with several risk factors, such as older age, unhealthy di-

etary habits, obesity, physical activity, and smoking, increasing the likelihood of developing the disease [3, 4]. Many patients undergo surgical tumor resection upon diagnosis. However, advancements in minimally invasive techniques have made laparoscopic surgery the preferred clinical option [5].

Compared to traditional open surgery, minimally invasive laparoscopic surgery offers several advantages, such as smaller incisions, less trauma, reduced blood loss, minimal tissue damage, and faster postoperative recovery. This technique enables precise cancer tissue removal, decreasing tumor progression and extending patient survival [6, 7]. However, despite these benefits, this invasive surgical approach requires CO₂ pneumoperitoneum and can be time-consuming. Postoperative complications, such as intestinal obstruction, may occur, resulting in extended hospital stays, elevated physical discomfort, and, in severe cases, life-threatening complications [8]. Some cases of perioper-

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ative intestinal obstruction are linked to improper surgical techniques, leading to conditions such as mesenteric hiatal hernia, trocar site hernia, or intussusception, all of which can cause mechanical obstruction [9, 10]. In such cases, additional surgical intervention is often necessary. However, dynamic intestinal obstruction triggered by impaired intestinal motility is more common [11].

Currently, the causes of dynamic intestinal obstruction remain poorly understood. However, previous study has revealed that the likelihood of developing this disease is lower after laparoscopic surgery compared to traditional open surgery [12]. Dynamic intestinal obstruction can significantly reduce recovery speed of patients, leading to extended hospital stays, higher medical costs, and need for secondary surgeries and additional complications in some cases. Several interventions have been implemented to mitigate the occurrence and impact of dynamic intestinal obstruction following laparoscopic surgery. These include comprehensive preoperative assessment and optimization, technical improvements during the procedure (such as reducing bowel manipulation and traction), early postoperative mobilization, proper nutritional support, and appropriate postoperative monitoring. While these approaches have been effective in reducing the incidence and severity of postoperative dynamic intestinal obstruction, some patients still experience this complication post-surgery. Therefore, it is crucial to explore its incidence and contributing factors to improve clinical practice and enhance patient outcomes. This research intends to investigate the factors influencing the incidence of dynamic intestinal obstruction after laparoscopic radical surgery for CRC. Patients who underwent laparoscopic radical surgery in the gastrointestinal surgery department of the People's Hospital of Xinjiang Uygur Autonomous Region, China, were selected as the study subjects. The objective is to analyze the incidence and contributing factors of post-surgery dynamic intestinal obstruction, with the hope of providing insights for clinical prevention approaches.

Study Participants and Research Methods

Study Participants

We collected clinical data from 218 CRC patients who underwent laparoscopic radical surgery in the Gastrointestinal Surgery Department of the People's Hospital of Xinjiang Uygur Autonomous Region, China, between January 2022 and December 2023. All surgeries were performed by the same team of physicians. Inclusion criteria for the study participants included: meeting the diagnostic criteria for CRC [13], confirmed through clinical pathology, newly diagnosed patients, eligible for laparoscopic radical surgery, with all patients undergoing the procedure, with a follow-up period of over one month. Exclusion criteria encompassed: diagnosis of other malignant tumors, patients with infectious or contagious diseases, hematological disorders, conversion to open surgery during laparoscopic surgery,

and patients with mental abnormalities or poor compliance, making complete investigation and follow-up challenging. Moreover, tumor pathological stages of the patients were as follows [14]: 45 cases in stage I, 49 cases in stage II, 88 cases in stage III, and 36 cases in stage IV.

This study was approved by the Clinical Research Ethics Committee of the People's Hospital of Xinjiang Uygur Autonomous Region (KY2024080101), China. Furthermore, the study design adhered to the ethical principles of the Declaration of Helsinki. The research committee of the People's Hospital of Xinjiang Uygur Autonomous Region has approved the waiver of informed consent in the study.

Criteria for Determining and Grouping Dynamic Intestinal Obstruction

The patients were followed for 30 days post-surgery, with weekly hospital visits to monitor any signs of dynamic intestinal obstruction. During follow-up, patients underwent routine blood assessments, urine examinations, blood biochemistry, vomit and stool analyses, X-rays, and computed tomography (CT) scans. Dynamic intestinal obstruction was assessed based on clinical symptoms, laboratory examination, and imaging, criteria adapted from previous literature [15]: (1) Clinical symptoms: Patients experienced the four primary symptoms, including abdominal pain, abdominal distension, vomiting, and cessation of flatus and defecation. Abdominal examination indicated visible a gastrointestinal pattern or peristalsis. In paralytic intestinal obstruction, there was no colic pain, bowel sounds were absent, and the entire abdomen appeared uniformly distended. In spastic intestinal obstruction, there was a sudden onset and disappearance of severe abdominal pain, diminished but not absent bowel sounds, irregular intervals, and no abdominal distension. (2) Laboratory tests: Routine blood examinations exhibited abnormal outcomes, such as elevated white blood cell and neutrophil counts. Routine urine examinations indicated increased specific gravity. Blood routine tests indicated elevated hemoglobin and hematocrit levels, along with fluid and electrolyte imbalances and acid-base imbalances. Vomit and stool contained a significant number of red blood cell (RBCs) and were positive for occult blood (Not all these indicators need to be present simultaneously). (3) Imaging: X-ray abdominal fluoroscopy or radiography indicated uniform distension of the stomach, colon, and small intestine in paralytic intestinal obstruction. In spastic intestinal obstruction, no substantial intestinal dilation or distension was observed. CT scans demonstrated intestinal dilation and gas-fluid levels.

Patients meeting these diagnostic criteria for dynamic intestinal obstruction were included in the complication group, while those who did not meet the criteria were placed in the control group. The number of patients experiencing dynamic intestinal obstruction during the follow-up period was recorded, and the postoperative incidence was computed.

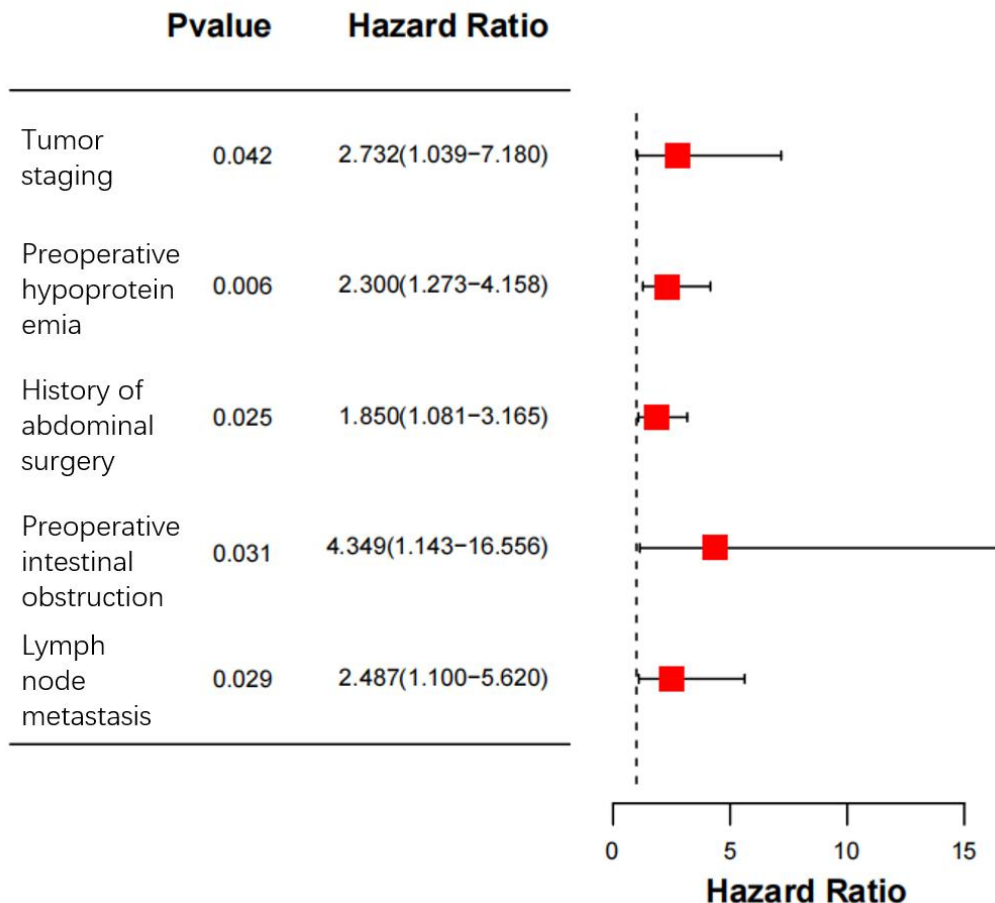


Fig. 1. Forest plot of multiple logistic regression analysis of factors influencing dynamic intestinal obstruction after laparoscopic colorectal radical surgery. The graph was generated using GraphPad Prism 18.0 Version (GraphPad Software Inc., San Diego, CA, USA).

Data Collection

The patients were interviewed to collect the necessary data using a well-designed patient information form. The data included variables such as gender, age, body mass index (BMI), education level, Quality of Life Score, tumor location, pathological tumor staging, degree of differentiation, tumor diameter, procedure duration, presence of hypertension, history of diabetes, hyperlipidemia (HLP), preoperative hypoproteinemia, history of abdominal surgery, smoking and alcohol use, preoperative intestinal obstruction, and postoperative abdominal infection.

Statistical Analysis

Statistical analysis was performed using SPSS 22.0 software (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test is used to determine whether the data conforms to normality. Measurement data that follow normal distribution were represented as mean $\pm$ standard deviation ($\bar{x} \pm s$) and analyzed using independent samples *t*-tests. Enumeration data were presented as frequencies and percentages and analyzed using the χ^2 test. Fig. 1 were both generated using

GraphPad Prism 18.0 Version (GraphPad Software Inc., San Diego, CA, USA). Logistic regression analysis identified significant risk factors for postoperative dynamic intestinal obstruction in CRC patients, with statistical significance set at $p < 0.05$.

Results

Postoperative Occurrence of Dynamic Intestinal Obstruction

Among the 218 patients, 42 cases (19.27%) developed postoperative dynamic intestinal obstruction, while the remaining 176 cases (80.73%) did not develop this complication following surgery. Additionally, among the CRC patients, 45 cases were in stage I, 49 in stage II, 88 in stage III, and 36 in stage IV.

Impact of Baseline Data on Dynamic Intestinal Obstruction Following Laparoscopic Colorectal Radical Surgery

Gender, age, BMI, and education level were used as baseline variables in a univariate analysis to assess their impact

Table 1. The impact of baseline data on dynamic intestinal obstruction following laparoscopic colorectal radical surgery.

Baseline variables		Complication group (n = 42)	Control group (n = 176)	χ^2/t	p-value
Gender	Male	22 (52.38)	103 (58.52)	0.523	0.470
	Female	20 (47.62)	73 (41.48)		
Age	≥60 years	6 (14.29)	42 (23.86)	1.812	0.178
	<60 years	36 (85.71)	134 (76.14)		
BMI	≥24 kg/m ²	11 (26.19)	56 (31.82)	0.505	0.478
	<24 kg/m ²	31 (73.81)	120 (68.18)		
Education level	Junior high school and below	17 (40.48)	84 (47.73)	0.717	0.397
	Senior high school and above	25 (59.52)	92 (52.27)		
Quality of Life Score		51.23 ± 4.98	52.43 ± 5.16	1.363	0.174

BMI, body mass index.

on postoperative dynamic intestinal obstruction. Among the 218 patients, 125 were males and 93 were females, with ages ranging from 44–69 years and an average age of 52.31 ± 2.17 years. As detailed in Table 1, there were no significant differences between the complication group and the control group in terms of gender, age, BMI, education level, or Quality of Life Score ($p > 0.05$). This demonstrates that baseline data did not contribute to the risk of developing dynamic intestinal obstruction following laparoscopic colorectal radical surgery.

Correlation between Clinical Data and Dynamic Intestinal Obstruction in Patients who Underwent Laparoscopic Colorectal Radical Surgery

The clinical data obtained included tumor location, pathological stages, degree of differentiation, tumor diameter, operation duration, presence of hypertension, history of diabetes, HLP, preoperative hypoproteinemia, history of abdominal surgery, smoking and alcohol use, preoperative intestinal obstruction, and postoperative abdominal infection. These factors were assessed using univariate analysis to examine their impact on the occurrence of postoperative dynamic intestinal obstruction.

The findings suggested no substantial statistical differences between the complication group and the control group in terms of tumor location, degree of differentiation, tumor diameter, procedure duration, presence of hypertension, history of diabetes, HLP, smoking and alcoholism history, and postoperative abdominal infection ($p > 0.05$). Nevertheless, the complication group exhibited a higher proportion of patients in stages III/IV (78.57%), preoperative hypoproteinemia (76.19%), abdominal surgery (69.05%), preoperative intestinal obstruction (52.38%), and lymph node metastasis (71.43%), all of which were significantly higher than in the control group ($p < 0.05$), as detailed in Table 2. Our findings indicate that tumor stage, preoperative hypoproteinemia, history of abdominal surgery, preoperative intestinal obstruction, and lymph node metastasis may be possible risk factors for developing postoperative dynamic intestinal obstruction.

Multivariate Analysis of Factors Influencing Dynamic Intestinal Obstruction Following Laparoscopic Colorectal Radical Surgery

The occurrence of dynamic intestinal obstruction following laparoscopic radical surgery for CRC was considered the dependent variable. Binary variables identified as potential influencing factors were employed as independent variables. The values assigned to these variables are detailed in Table 3. A Logistic regression analysis model was established, which revealed tumor staging, preoperative hypoproteinemia, history of abdominal surgery, preoperative intestinal obstruction, and lymph node metastasis as all considered independent risk factors for postoperative dynamic intestinal obstruction. These factors elevated the risk of dynamic intestinal obstruction in CRC patients undergoing laparoscopic radical surgery by 2.732, 2.300, 1.850, 4.349, and 2.487 times, respectively (Table 4, Fig. 1).

Discussion

Early symptoms of CRC are often subtle, but as the disease progresses, more severe digestive symptoms such as abdominal pain, diarrhea, and hematochezia may develop. If not treated promptly, cancer cells can easily metastasize to other organs, posing serious threats to the patient's overall health and life [16]. Laparoscopic radical surgery is a commonly used clinical approach for treating CRC. Previous studies have consistently reported that minimally invasive laparoscopic surgery offers good therapeutic efficacy and safety [17, 18]. This approach provides a clearer, more intuitive surgical view, making the procedure easier for physicians while reducing incision size, which helps alleviate symptoms and attenuate postoperative complications [19]. Nevertheless, some patients still experience dynamic intestinal obstruction after surgery, which can hamper postoperative flatus and defecation, prolong hospitalization, and hinder recovery [20].

Intestinal obstruction is a frequent complication in CRC patients. Previous study has revealed that in CRC patients, the primary causes of acute obstructive lesions are tumor infiltration and spread to adjacent structures. Acute obstruction typically develops within an average of 3 days from

Table 2. A correlation between clinical data and dynamic intestinal obstruction after laparoscopic colorectal radical surgery.

Clinical variable		Complication group (n = 42)	Control group (n = 176)	χ^2	p-value
Tumor location	Colon	12 (28.57)	60 (34.09)	0.467	0.494
	Rectum	30 (71.43)	116 (65.91)		
Tumor staging	Stages I/II	9 (21.43)	85 (48.30)	9.979	0.002
	Stages III/IV	33 (78.57)	91 (51.70)		
Differentiation degree	Moderate/poor differentiation	25 (59.52)	102 (57.95)	0.034	0.853
	High differentiation	17 (40.48)	74 (42.05)		
Tumor diameter	≥ 5 cm	11 (26.19)	54 (30.68)	0.327	0.568
	< 5 cm	31 (73.81)	122 (69.32)		
Surgical duration	≥ 200 min	19 (45.24)	83 (47.16)	0.050	0.823
	< 200 min	23 (54.76)	93 (52.84)		
Presence of hypertension	Yes	16 (38.10)	71 (40.34)	0.071	0.789
	No	26 (61.90)	105 (59.66)		
Presence of diabetes	Yes	25 (59.52)	93 (52.84)	0.610	0.435
	No	17 (40.48)	83 (47.16)		
Presence of HLP	Yes	18 (42.86)	85 (48.30)	0.402	0.526
	No	24 (57.14)	91 (51.70)		
Preoperative hypoproteinemia	Yes	32 (76.19)	90 (51.14)	8.637	0.003
	No	10 (23.81)	86 (48.86)		
History of abdominal surgery	Yes	29 (69.05)	75 (42.61)	9.497	0.002
	No	13 (30.95)	101 (57.39)		
Smoking and alcoholism history	Yes	17 (40.48)	69 (39.20)	0.023	0.880
	No	25 (59.52)	107 (60.80)		
Preoperative intestinal obstruction	Yes	22 (52.38)	57 (32.39)	5.867	0.015
	No	20 (47.62)	119 (67.61)		
Lymph node metastasis	Yes	30 (71.43)	86 (48.86)	6.935	0.008
	No	12 (28.57)	90 (51.14)		
Postoperative abdominal infection	Yes	16 (38.10)	53 (30.11)	0.999	0.318
	No	26 (61.90)	123 (69.89)		

HLP, hyperlipidemia.

hospital admission, with over 75% of cases associated with serious underlying conditions related to acute intestinal obstruction [21]. Grigorean *et al.* [22] reported that low intestinal obstruction is a common complication in CRC, occurring in about 20% of cases. Its occurrence is nonspecific and often overlooked or misinterpreted. In our study, among the 218 patients who underwent laparoscopic radical surgery for CRC, 42 developed postoperative dynamic intestinal obstruction, leading to an incidence rate of 19.27%. This significant rate highlights the importance of investigating the factors affecting dynamic intestinal obstruction after laparoscopic colorectal radical surgery and the need for effective interventions to improve clinical recovery.

This study grouped patients based on whether they experienced postoperative dynamic intestinal obstruction and compared their clinical data employing univariate and multivariate analyses. The findings confirmed that tumor staging, preoperative hypoproteinemia, history of abdominal surgery, pre-existing intestinal obstruction, and lymph node metastasis were independent risk factors for post-surgery dynamic intestinal obstruction, aligned with prior research

outcomes. Wang *et al.* [23], in an observational study of 1244 consecutive patients, observed that preoperative intestinal obstruction, $>10\%$ weight loss, low albumin levels, and longer surgery duration were significant predictors of early postoperative small intestine obstruction. Patients with poorer overall condition (such as those with $>10\%$ weight loss, hypoproteinemia, or preoperative intestinal obstruction) and those who underwent longer procedures were more likely to develop intestinal obstruction. Schölin *et al.* [24] also observed that tumor stage affected the risk of colon obstruction after cancer resection. They reported that incidence rates were 2.8% for stage I, 6.6% for stage II, and 7% for stage III, with higher tumor stages correlating with an elevated risk of postoperative intestinal obstruction. The findings in our study can be due to several factors: (1) Patients with advanced tumor stages tend to have more severe conditions, with higher tumor cell invasion and deeper infiltration into surrounding tissues. This increases surgical complexity and induces a higher release of inflammatory mediators during surgery, leading to intestinal wall edema and abdominal or intestinal adhesions, thereby increasing

Table 3. Factors associated with the occurrence of dynamic intestinal obstruction following laparoscopic colorectal radical surgery and value assignment.

Variables	Relevant factors	Staging and value assignment
X1	Tumor staging	Stages I/II: 0; Stages III/IV: 1
X2	Preoperative hypoproteinemia	No: 0; Yes: 1
X3	History of abdominal surgery	No: 0; Yes: 1
X4	Preoperative intestinal obstruction	No: 0; Yes: 1
X5	Lymph node metastasis	No: 0; Yes: 1
Y	Postoperative dynamic intestinal obstruction	No: 0; Yes: 1

Table 4. Multiple logistic regression analysis of factors influencing dynamic intestinal obstruction after laparoscopic colorectal radical surgery.

Variables	B	SE	Wald	p-value	OR	95% CI
Tumor staging	1.005	0.493	4.156	0.042	2.732	1.039~7.180
Preoperative hypoproteinemia	0.833	0.302	7.608	0.006	2.300	1.273~4.158
History of abdominal surgery	0.615	0.274	5.038	0.025	1.850	1.081~3.165
Preoperative intestinal obstruction	1.470	0.682	4.646	0.031	4.349	1.143~16.556
Lymph node metastasis	0.911	0.416	4.796	0.029	2.487	1.100~5.620

B, Regression Coefficient; SE, Standard error; OR, Odds Ratio; CI, Confidence Interval.

the risk of dynamic intestinal obstruction [25]. (2) Patients with preoperative hypoproteinemia often exhibit more severe inflammatory reactions at the incision site postoperatively. This can increase edema and dilation of the intestinal wall, leading to intra- and extra-intestinal inflammatory exudates. These conditions hinder the recovery of intestinal function, thereby elevating the incidence of postoperative dynamic intestinal obstruction [26]. (3) Patients with a history of abdominal surgery already have some degree of intestinal damage, and undergoing repeated laparoscopic radical surgery exacerbates this injury. This mechanism promotes peritoneal adhesions in the surgical area, affecting splanchnic muscle function and intestinal motility, thereby increasing the risk of dynamic intestinal obstruction [27]. (4) Patients with preoperative intestinal obstruction experience higher intestinal pressure, which can result in capillary and lymphatic congestion and inflammatory reactions. These factors compromise splanchnic muscle function and can trigger dynamic intestinal obstruction [28]. (5) Patients with lymph node metastasis often require lymph node dissection during surgery to enhance therapeutic outcomes. However, this procedure can increase the surgical scope, damage abdominal organs and lymphatics, and potentially lead to lymphatic obstruction. Additionally, strong stimulation of the peritoneum can disrupt peristalsis and lead to intestinal and abdominal adhesions, contributing to dynamic intestinal obstruction [29].

Our study suggests that clinical interventions for patients undergoing laparoscopic radical surgery for CRC should consider these factors. Strategies should encompass accurately determining tumor stage and lymph node metastasis preoperatively, adopting comprehensive treatment plans to minimize surgical trauma, comprehensively evaluating patient conditions, reviewing the history of prior abdomi-

nal surgeries, and selecting appropriate treatment strategies based on patient circumstances by experienced physicians to mitigate surgical damage to the peritoneum. Furthermore, for patients with preoperative dynamic intestinal obstruction, measures such as prokinetic agents and gastrointestinal decompression are recommended. Moreover, it is necessary to actively monitor the patients for symptoms of hypoproteinemia and promptly address them to prevent the occurrence of postoperative dynamic intestinal obstruction as much as possible.

However, our study has certain limitations. It was conducted at a single center, with all data collection, patient recruitment, and analysis occurring within one medical institution. While this design facilitates data management and access, it also has significant limitations. The primary concern is that results from a single-center study may not fully represent a broader patient population. Different medical centers have varying patient demographics, treatment modalities, and data recording practices, which can affect the generalizability of the study findings. Therefore, caution is needed when applying the study's conclusions to other settings or patient groups.

Additionally, this is a retrospective study that relies on existing medical records and data. While this allows for the efficient analysis of a large amount of information, it also presents the risk of selection bias, meaning the data may not be entirely random or comprehensive. To address these challenges in the future, we could consider conducting multi-center studies to increase sample diversity and representativeness or adopting more prospective study designs to minimize data selection bias. These approaches will provide valuable insights for future research and contribute to advancing the field and improving clinical practice.

Conclusions

In conclusion, advanced tumor stage, preoperative hypoproteinemia, prior abdominal surgery, preoperative intestinal obstruction, and lymph node metastasis are independent risk factors associated with an increased risk of postoperative dynamic intestinal obstruction in patients undergoing laparoscopic radical surgery for CRC. Clinically, it is crucial to pay attention to patients exhibiting these characteristics and adapt targeted preventive measures to reduce the risk of postoperative dynamic intestinal obstruction.

Availability of Data and Materials

All experimental data included in this study can be obtained by contacting the first author if needed.

Author Contributions

MY, XA designed the research study; CWY, TL performed the research; XA, CWY collected and analyzed the data. MY, TL has been involved in drafting the manuscript. All authors contributed to important editorial changes in the manuscript. All authors give final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study was approved by the Clinical Research Ethics Committee of the People's Hospital of Xinjiang Uygur Autonomous Region (KY2024080101), China. Furthermore, the study design adhered to the ethical principles of the Declaration of Helsinki. The research committee of the People's Hospital of Xinjiang Uygur Autonomous Region has approved the waiver of informed consent in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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