BMC Gastroenterology

RESEARCH

Open Access

The effect of cardiovascular disease on the perioperative period of radical surgery in elderly rectal cancer

Ruilong Niu[1†], Yujuan Jiang[2†], Zhibing Bi[1], Huiping Zhang[1], Xianghuang Mei[1], Jianjun Bi[2], Wei Xing[3*], Wei Guo[1*] and Jianwei Liang[2*]

Abstract

Aim To investigate the impact of preoperative cardiovascular disease on the perioperative period of rectal cancer patients over 75 years old.

Methods The clinicopathological data of 625 elderly patients aged ≥ 75 years who underwent radical rectal cancer surgery in the Cancer Hospital of the Chinese Academy of Medical Sciences and affiliated Heji Hospital of Changzhi Medical College from January 2011 to December 2022 were retrospectively collected and analyzed. According to preoperative comorbidities, all patients were divided into cardiovascular disease group ($n=361$) and non-cardiovascular disease group ($n=264$). One hundred and ninety-two pairs were selected from each group through Propensity score-matched to further analysis. Perioperative indexes and postoperative complications were compared between the two groups.

Results There were no significant differences in clinicopathological data between the two groups ($P>0.05$). The proportion of elderly patients with cardiovascular disease who went to ICU after radical surgery was significantly higher than those without cardiovascular disease (19.3% vs. 10.4%, $P=0.015$). There was no significant difference between the two groups in the time to first flatus (3.0 vs. 3.5 days, $P=0.332$) and postoperative hospital stay (11.3 vs. 10.5 days, $P=0.297$). One patient in the cardiovascular disease group died due to pulmonary embolism. A total of 100 patients (26.0%) developed postoperative complications, and the incidence of overall complications (30.7% vs. 21.4%, $P=0.036$) and grade 3–5 complications (12.5% vs. 6.3%, $P=0.036$) in the cardiovascular disease group was significantly higher than that in the non-cardiovascular disease group. In terms of gastrointestinal disorders, the incidence of anastomotic leakage (6.8% vs. 2.1%, $P=0.026$) in elderly patients with cardiovascular diseases was significantly higher

†Ruilong Niu and Yujuan Jiang contributed equally to this work.

*Correspondence:
Wei Xing
xingwei202309@163.com
Wei Guo
guowei2022a@163.com
Jianwei Liang
liangjw1976@163.com

Full list of author information is available at the end of the article

than that in patients without cardiovascular disease. In addition, the incidence of cardiac disorders (8.3% vs. 2.6%, $P=0.014$) in elderly patients with cardiovascular disease was significantly higher.

Conclusion Elderly rectal cancer patients over 75 years old with cardiovascular disease are more likely to develop severe complications after radical surgery, especially anastomotic leakage and cardiac disorders.

Keywords Rectal cancer, Elderly, Cardiovascular disease, Complications, Surgery

Introduction

With the improvement of living standards and the increase of life expectancy, the aging of China's population has become increasingly severe, which has led to an increasing proportion of elderly colorectal cancer patients [1, 2]. Colorectal cancer is one of the common malignancies of the digestive tract, ranking third and fourth in the world in incidence and mortality [3]. Total mesorectal excision (TME) is the gold standard for rectal cancer surgery [4]. Following the introduction this standard surgical procedures, the 5-year local recurrence rate of locally advanced rectal cancer was reduced to 5%10% [5–7]. Therefore, radical surgery is still used as a potential cure for rectal cancer. Radical surgery for rectal cancer involves tumor resection and digestive tract reconstruction, and there is a risk of a series of postoperative complications, such as anastomotic leakage, pelvic infection and intestinal obstruction. However, basic disorders like cardiopulmonary disease are more complicated in senior individuals, increasing the danger of surgery and the likelihood of complications after surgery. Once the occurrence of serious complications, it will significantly affect the quality of life and prognosis.

One of the most prevalent chronic systemic diseases affecting the elderly is cardiovascular disease. On the other hand, there is currently a paucity of evidence-based medical research regarding the effects of radical surgery on perioperative rehabilitation in older patients with cardiovascular disease who underwent the procedure for rectal cancer. As a result, we created a propensity score-matched (PSM) two-center study to look at how cardiovascular illnesses affected senior rectal cancer patients' perioperative period.

Materials and methods

Patients

Baseline and clinicopathologic data of elderly patients who underwent radical surgery at Cancer Hospital of Chinese Academy of Medical Sciences and affiliated Heji Hospital of Changzhi Medical College from January 2011 to December 2022 were retrospectively analyzed. The inclusion criteria are as follows: (1) age≥75 years; (2) The primary tumor is located in the rectum; (3) Pathological diagnosis is rectal adenocarcinoma. The following conditions were excluded from the study: (1) distant metastasis; (2) palliative surgery; (3) emergency surgery due to intestinal obstruction and intestinal perforation; (4) other malignancies. According to preoperative comorbidities, all patients were divided into cardiovascular disease group and non-cardiovascular disease group. This study was approved by the ethics committee of Cancer Hospital, Chinese Academy of Medical Sciences (LA2016-22-01), and written informed consent was obtained from each patient included in present study.

Diagnosis and treatment

All patients were required to complete colonoscopy, rectal MRI, and CT of the chest, abdomen and pelvic before surgery to evaluate the primary tumor. TNM staging was performed using the American Joint Committee on Cancer staging system (Edition 8). Preoperative cardiac function and vascular conditions of all patients were assessed, including electrocardiogram, echocardiogram, blood pressure monitoring, lower limb physical fitness scores, and if necessary, 24-hour dynamic electrocardiogram, myocardial nuclide coronary angiography and other examinations were performed. Cardiovascular diseases, including hypertension, coronary heart disease, cardiac insufficiency, arrhythmia, and histories of cardiac surgeries etc., and vascular diseases such as aortic aneurism, peripheral arteriopathy, cerebral attack etc. can be diagnosed if one of the above criteria is met. Previous hospital diagnosis (examination data available) or this admission examination can be used as criteria for diagnosing cardiovascular disease. Neoadjuvant chemoradiotherapy (CRT) is recommended for patients at high risk of recurrence, such as T4 stage and multiple lymph node metastases. Patients over 80 years of age are not treated with nCRT. The following conditions after surgery require admission to the ICU for further close monitoring and treatment: (1) severe arrhythmia or cardiac arrest during surgical anesthesia; (2) systolic blood pressure remains 180mmHg after general treatment for severe hypertension, or less than 80mmHg after treatment for severe hypotension; (3) Respiratory function was poor before anesthesia, severe hypoxemia was observed in 90% of SaO2 after anesthesia, and respiration must be assisted by mechanical ventilation; (4) The operation was complicated and time-consuming, and complicated with serious cardiopulmonary organic diseases before operation. The unstable vital signs after operation required close monitoring.

Postoperative complications

Postoperative complications are defined as the occurrence of one or more outcomes related to the operation after surgery that prolong the patient's hospital stay or result in the patient's readmission to the hospital. Postoperative complications were graded according to the Clavien–Dindo classification [8]. Depending on the site of complications, all complications are classified as gastrointestinal disorders, cardiac disorders, respiratory disorder, renal and urinary disorders and other disorders. Urinary retention was defined as residual urine volume > 50 mL in the bladder found on ultrasound after catheter removal. According to the classification of anastomotic leakage according to the International Study Group of Rectal Cancer (ISREC) in 2010 [9], only anastomotic leakage with clinical symptoms requiring therapeutic intervention were counted in present study, that is, grade B and C.

Statistical analysis

SPSS software version for Windows (IBM Corp, Armonk, NY, USA) was used for statistical analysis. The PSM was conducted using a logistic regression model and nearest neighbor matching algorithm, and the two groups of patients were matched in a 1:1 ratio according to the score to eliminate selection bias and potential confounders. Age, gender, body mass index, preoperative albumin and hemoglobin levels, ASA score, nCRT, other comorbidities, prior abdominal surgery, surgical technique, surgical procedure, tumor location, distance from anal margin, diverting ostomy, and clinical TNM stage were among the covariates. Quantitative data were analyzed by the *t* test or Mann-Whitney U test and presented as mean ± standard deviation. Categorical data were presented as frequency and percentage and analyzed by the Chi-squared test or Fisher exact method. All tests were two-sided, and the *P* value less than 0.05 was considered to indicate statistical significance.

Results

Clinical and pathological characteristics

A total of 625 patients were included in the study, divided into cardiovascular disease group ($n=361$) and non-cardiovascular disease group ($n=264$). Table 1 showed the classification of cardiovascular diseases in 361 patients. Among them, 192 marched pairs were selected through PSM. The clinical and pathological characteristics of patients before and after matching were presented in Table 2. Before PSM, there were significant differences in terms of preoperative albumin level, other comorbidities, and distance of tumor from anal margin between two groups ($P<0.05$). Before PSM, patients in the cardiovascular group had significantly lower average preoperative albumin levels (38.3 vs. 39.1 g/L, $P=0.022$) than in the non-cardiovascular group. In addition, patients with cardiovascular disease often have other comorbidities (36.3% vs. 18.9%, $P<0.001$). The distance from tumor to anal verge (5.4 vs. 6.2 cm, $P=0.044$) in the cardiovascular disease group was significantly lower than that in the non-cardiovascular disease group. After PSM, two groups were well balanced in aspects of age, gender, body mass index, preoperative hemoglobin level, preoperative albumin level, American Society of Anesthesiologists (ASA) score, nCRT, other comorbidity, previous abdominal surgery, surgical approach, surgical procedure, tumor location, Distance of tumor from anal margin, diverting ostomy and clinical TNM stage ($P>0.05$).

Table 1 Classification of cardiovascular diseases in 361 patients

Cardiovascular diseases	*N* = 361
Hypertension	192 (53.2)
Coronary heart disease	60 (16.6)
Cardiac insufficiency	71 (19.7)
Arrhythmia	48 (13.3)
Aortic aneurism	25 (6.9)
Peripheral vascular disease	44 (12.2)
Cerebral attack	24 (6.6)
Other	14 (3.9)

Surgical and pathological outcomes

As shown in Table 3, the operative time (153.4 vs. 143.6 min, $P=0.378$) and estimated blood loss (93.3 vs. 78.4 ml, $P=0.211$) were similar in both groups. The proportion of elderly patients with cardiovascular disease who went to ICU after radical surgery was significantly higher than those without cardiovascular disease (19.3% vs. 10.4%, $P=0.015$). There was no significant difference between the two groups in the time to first flatus (3.0 vs. 3.5 days, $P=0.332$) and postoperative hospital stay (11.3 vs. 10.5 days, $P=0.297$). One patient in the cardiovascular disease group died due to pulmonary embolism. There was no statistical difference between the two groups in pathological results such as the pathological TNM stage, differentiation, perineural invasion, lymphatic invasion and lymph nodes harvested ($P>0.05$).

Postoperative complications

Among the 384 patients, a total of 100 patients developed postoperative complications, including 59 in the cardiovascular disease group and 41 in the non-cardiovascular disease group, and there were significant statistical differences between the two groups ($P=0.036$). According to the classification of complications, the incidence of grade 3–5 complications (12.5% vs. 6.3%, $P=0.036$) in the cardiovascular disease group was significantly higher than that in the non-cardiovascular disease group, while the incidence of grade 1–2 complications (18.2% vs. 15.1%, $P=0.411$) was similar between the two groups. In terms

Table 2 Clinical and pathological characteristics of patients from cardiovascular diseases and non- cardiovascular diseases group before and after matching

Variables	Total cohort			Matched cohort		
	Cardiovascular diseases (*n* = 361)	Non- Cardiovascular diseases (*n* = 264)	*P*	Cardiovascular diseases (*n* = 192)	Non- Cardiovascular diseases (*n* = 192)	*P*
Age (mean ± SD, years)	78.3 ± 4.2	77.5 ± 3.9	0.274	77.9 ± 4.1	77.6 ± 3.9	0.545
Gender(%)			0.214			0.678
Male	205 (56.8)	163 (61.7)		111	115	
Female	156 (43.2)	101 (38.3)		81	77	
BMI (mean ± SD, kg/m^2)	23.5 ± 3.0	22.9 ± 3.2	0.145	23.3 ± 3.0	23.0 ± 3.0	0.692
Preoperative albumin levels (mean ± SD, g/L)	38.3 ± 4.3	39.1 ± 4.5	0.022	38.3 ± 4.3	38.5 ± 4.4	0.432
Preoperative hemoglobin levels (mean ± SD, g/L)	124.4 ± 17.2	121.4 ± 16.2	0.185	123.6 ± 15.3	121.7 ± 16.0	0.384
ASA score(%)			0.250			0.307
I-II	176 (48.8)	141 (53.4)		91 (47.4)	101 (52.6)	
III-IV	185 (51.2)	123 (46.6)		101 (52.6)	91 (47.4)	
nCRT	65 (18.0)	53 (20.1)	0.514	36 (18.8)	38 (19.8)	0.796
Other comorbidities (%)	131 (36.3)	50 (18.9)	< 0.001	46 (24.0)	38 (19.8)	0.323
Endocrine diseases	89 (24.7)	34 (12.9)	< 0.001	40 (20.8)	32 (16.7)	0.360
Respiratory diseases	20 (5.5)	6 (2.3)	0.043	2 (1.0)	2 (1.0)	1.000
Urological diseases	9 (2.5)	4 (1.5)	0.397	1 (0.5)	1(0.5)	1.000
Nervous system diseases	5 (1.4)	3 (1.1)	0.785	2 (1.0)	1 (0.5)	0.562
Bone and joint diseases	8 (2.2)	3 (1.1)	0.311	1 (0.5)	2 (1.0)	0.562
Previous abdominal surgery	68 (18.8)	53 (20.1)	0.699	35 (18.2)	38 (19.8)	0.696
Surgical approach (%)			0.127			0.758
Open	174 (48.2)	111 (42.0)		86 (44.8)	83 (43.2)	
Laparoscopic	187 (51.8)	153 (58.0)		106 (55.2)	109 (56.8)	
Surgical procedure			0.241			0.824
Low anterior resection	256 (70.9)	194 (73.5)		138 (71.9)	140 (72.9)	
Abdominoperineal resection	88 (24.4)	52 (19.7)		44 (22.9)	40 (20.8)	
Hartmann procedure	17 (4.7)	18 (6.8)		10 (5.2)	12 (6.3)	
Tumor location			0.383			0.910
High rectum (< 5 cm)	92 (25.5)	78 (21.4)		50 (26.1)	51 (26.6)	
Middle rectum (5–10 cm)	127 (35.2)	95 (36.0)		73 (38.0)	76 (39.6)	
Low rectum (10–15 cm)	142 (39.3)	91 (34.5)		69 (35.9)	65 (33.8)	
Distance of tumor from anal margin (mean ± SD, cm)	5.4 ± 3.7	6.2 ± 3.9	0.044	5.8 ± 3.5	6.0 ± 3.9	0.542
Diverting ostomy	204 (56.5)	133 (50.4)	0.129	102 (53.1)	97 (50.5)	0.610
Clinical TNM stage			0.176			0.678
I-II	159 (44.0)	102 (38.6)		81 (42.2)	77 (40.1)	
III	202 (56.0)	162 (61.4)		111 (57.8)	115 (59.9)	

Abbreviates BMI, body mass index; ASA, American Society of Anesthesiologists; nCRT, Neoadjuvant chemoradiotherapy

of gastrointestinal disorders, the incidence of anastomotic leakage (6.8% vs. 2.1%, $P=0.026$) in elderly patients with cardiovascular diseases was significantly higher than that in patients without cardiovascular disease. In addition, the incidence of cardiac disorders (8.3% vs. 2.6%, $P=0.014$) in elderly patients with cardiovascular disease was significantly higher. In addition, there was no significant statistical difference between the two groups in terms of respiratory disorder, renal and urinary disorders, and other disorders ($P>0.05$) (Table 4).

Discussion

With the acceleration of aging society, the incidence of the elderly colorectal cancer is increasing [1]. However, elderly patients have many underlying diseases and poor organ reserve, which leads to a high risk of perioperative death. Relevant studies have shown that preoperative co-morbidity is the main cause of postoperative death in patients with colorectal cancer [10]. However, there is still a lack of clinical evidence on whether cardiovascular diseases such as hypertension and coronary heart disease, as common chronic diseases in the elderly, increase the perioperative risk of colorectal cancer patients in the elderly. An et al. conducted a retrospective study in 2016

Table 3 Surgical and pathological results of patients from cardiovascular diseases and non- cardiovascular diseases group after matching

Outcomes	Cardiovascular diseases (*n* = 192)	Non- Cardiovascular diseases (*n* = 192)	*P*
Operative time (mean ± SD, min)	153.4 ± 57.1	143.6 ± 47.2	0.378
Estimated blood loss (mean ± SD, ml)	93.3 ± 74.1	78.4 ± 69.1	0.211
Blood transfusion (%)	27 (14.1)	21 (10.9)	0.355
ICU admission (%)	37 (19.3)	20 (10.4)	0.015
Time to first flatus (mean ± SD, days)	3.0 ± 1.3	3.5 ± 1.5	0.332
Postoperative hospital stay (mean ± SD, days)	11.3 ± 4.2	10.5 ± 4.1	0.297
Re-operation	7 (3.6)	5 (2.6)	0.557
Mortality	1 (0.5)	0 (97.4)	1.000
Pathological TNM stage			0.470
I-II	107 (55.7)	114 (59.4)	
III	85 (44.3)	78 (30.6)	
Differentiation			0.729
Poor	34 (17.7)	38 (19.8)	
Moderate	140 (72.9)	133 (69.3)	
High	18 (9.4)	21 (10.9)	
Perineural invasion	73 (38.0)	77 (40.1)	0.676
Lymphatic invasion	36 (18.8)	44 (22.9)	0.315
Lymph nodes harvested	17.2 ± 3.4	16.6 ± 2.8	0.234

Table 4 Postoperative complications of patients from cardiovascular diseases and non- cardiovascular diseases group after matching

Outcomes	Cardiovascular diseases (*n* = 192)	Non- Cardiovascular diseases (*n* = 192)	*P*
Postoperative complications	59 (30.7)	41 (21.4)	0.036
I-II	35 (18.2)	29 (15.1)	0.411
III-V	24 (12.5)	12 (6.3)	0.036
Gastrointestinal disorders	22 (11.5)	16 (8.3)	0.305
Anastomotic leakage	13 (6.8)	4 (2.1)	0.026
Ileus	7 (3.6)	8 (4.2)	0.792
Gastroparesis	4 (2.1)	5 (2.6)	1.000
Gastrointestinal hemorrhage	2 (1.0)	3 (1.6)	1.000
Cardiac disorders	16 (8.3)	5 (2.6)	0.014
Arrhythmia	9 (4.7)	4 (2.1)	0.158
Cardiac failure	4 (2.1)	1 (0.5)	0.372
Acute coronary syndrome	4 (2.1)	2 (1.0)	0.685
Hypertensive emergency	1 (0.5)	0 (0)	1.000
Pulmonary embolism	1 (0.5)	0 (0)	1.000
Respiratory disorder	6 (3.1)	5 (2.6)	0.760
Pneumonia	4 (2.1)	5 (2.6)	1.000
Pleural effusion	2 (1.0)	1 (0.5)	1.000
Atelectasis	3 (1.6)	3 (1.6)	1.000
Renal and urinary disorders	14 (7.3)	12 (6.3)	0.685
Urinary infection	3 (1.6)	3 (1.6)	1.000
Renal failure	2 (1.0)	1 (0.5)	1.000
Urinary retention	11 (5.7)	10 (5.2)	0.822
Other disorders	31(16.1)	25 (13.0)	0.386
Abdominal abscess	13 (6.8)	7 (3.6)	0.168
Intra-abdominal hemorrhage	5 (2.6)	2 (1.0)	0.449
Abdominal or perineal incision infection	18 (9.4)	15 (7.8)	0.585
Delirium	5 (2.6)	5 (2.6)	1.000
Chylous ascites	2 (1.0)	3 (1.6)	1.000

to explore the impact of cardiovascular disease on postoperative complications in elderly patients with colorectal cancer over 65 years old [11]. Our study is similar, but the purpose of this study is to study the influence of cardiovascular diseases on the perioperative period of elderly patients with rectal cancer over 75 years old, and PSM is used to reduce the interference of confounding factors.

Relevant literature reports that the incidence of postoperative complications in elderly colorectal cancer patients in China is about 25-30% [11]. In this study, among the 384 patients in matched cohort, 26% (100/384) of elderly rectal cancer patients developed postoperative complications, which was basically consistent with the literature. In addition, postoperative complications are graded according to severity and treatment, and the results showed that the incidence of overall (30.7% vs. 21.4%, $P=0.036$) and grade 3–5 postoperative complication (12.5% vs. 6.3%, $P=0.036$) in the cardiovascular disease group were significantly higher than in the non-cardiovascular disease group. Only one patient in this group died in hospital due to pulmonary embolism after surgery, and the mortality rate was inconsistent with the literature. It may be related to the following reasons: (1) There were only two cases with ASA score of grade IV before surgery. For elderly patients with rectal cancer who had myocardial infarction, cerebrovascular accident, or complicated with myocardial ischemia, severe cardiac valve dysfunction and other serious organic diseases in the last 3 months, the risk of perioperative death was too high. Therefore, conservative treatment such as endoscopic stenting or adjuvant chemoradiotherapy is usually recommended; (2) In this study, only death cases in hospital were counted, and cardiovascular accidents occurred after discharge (recovery or transferred to hospital) were not counted; (3) The number of cases in this study was relatively small, and there was a certain bias, resulting in a low mortality rate.

The occurrence of anastomotic leakage after rectal cancer surgery not only extends the length of hospital stay, wastes unnecessary medical resources, but also reduces the postoperative quality of life of patients and significantly increases the postoperative local recurrence rate [12–14]. Relevant literature has reported that the incidence of anastomotic leakage for rectal cancer is about

5–10% [15–17], while the incidence of asymptomatic anastomotic leakage is up to 50% [18]. In this study, only grade B and C anastomotic leakage were counted, and the results showed that the incidence of anastomotic leakage in elderly rectal cancer patients over 75 years old was 4.4% (17/384). Meanwhile, our study found that the incidence of anastomotic leakage in patients with cardiovascular disease was significantly higher than that in patients without cardiovascular disease (6.8% vs. 2.1%, $P=0.026$). A basic study by Fawcett found that blood microcirculation in the serous layer of the intestinal wall is an important condition for anastomosis healing [19]. Laser Doppler blood flow detection also showed that the decrease of blood flow signal in the rectal stump was closely related to the occurrence of anastomotic leakage [20]. Patients with cardiovascular diseases often have varying degrees of systemic atherosclerosis, including mesenteric vascular lesions, which further affect the blood supply of anastomotic microcirculation. Therefore, for elderly rectal cancer patients with cardiovascular disease, the surgeon should make a comprehensive assessment of the general condition, and if necessary, do not perform gastrointestinal reconstruction, or consider prophylactic ostomy to reduce the symptoms of anastomotic leakage.

A retrospective study by An et al. showed that the incidence of postoperative cardiovascular disorders in elderly patients with colorectal cancer over 65 years old complicated with cardiovascular diseases was significantly higher than that in patients without cardiovascular diseases (7.4% vs. 0.8%, $P=0.010$). Consistent with previous study, in present study, the analysis and comparison of rectal cancer patients over 75 years old found that patients with preoperative cardiovascular disease also had significantly more postoperative cardiac disorders than patients without cardiovascular disease (8.3% vs. 2.6%, $P=0.014$). The exercise reserve, left ventricular ejection fraction, and other cardiovascular functions of patients with colorectal cancer are significantly lower than those of healthy people of the same age [11]. For elderly patients with colorectal cancer who also have cardiovascular disease, there is a high possibility of cardiovascular decompensation after surgery, which makes them more likely to have more serious cardiovascular complications. Therefore, for elderly patients with preoperative cardiovascular disease, the patient's blood pressure and electrocardiogram should be closely monitored after surgery, and early detection and timely treatment should be carried out.

This article summarizes the perioperative cardiovascular medication in patients with general anesthesia: (1) Patients with long-term oral calcium channel blockers and nitrates and other antihypertensive drugs before surgery do not need to stop the drug before surgery. Patients who have taken angiotensin converting enzyme inhibitor diuretic digitalis and other heart failure control drugs for a long time should stop taking them in the morning of operation. (2) For patients at high risk of thrombosis who require antiplatelet or anticoagulant therapy for a long time, the drug is discontinued 4–5 days before surgery, and low-dose low-molecular weight heparin replacement therapy is used perioperatively to prevent deep vein thrombosis and myocardial infarction. (3) For the treatment of postoperative hypertension, the etiology should be identified first, and irritants such as excessive amount of painful fluid should be excluded. Intravenous antihypertensive drugs such as urapidil and esmolol should be used in time, and combined medication can be used when necessary. (4) Postoperative hypotension is caused by many factors, such as postural change, insufficient blood volume and the use of analgesic pump, which need to be identified and timely treatment, vasoactive drugs can be applied when necessary. (5) The cause of perioperative acute coronary syndrome is the imbalance between myocardial oxygen supply and demand, and prevention is more important than treatment. High-risk patients need to monitor electrocardiogram, myocardial enzymes, heart rate, and blood pressure dynamically. Reasonable anti-infection, anticoagulation and maintenance of effective circulating blood volume after surgery. Once acute coronary syndrome develops, antiplatelet and plaque stabilization therapy as soon as possible after resuming enteral diet can prevent reinfarction or enlargement of infarct area.

Our study have several limitations. Firstly, there was heterogeneity in patient selection and treatment strategies due to the retrospective nature of the present study. Subjective factors of anesthesiologists may influence the choice of indications for ICU after surgery. Furthermore, this study spans 12 years, treatment strategies and medical devices are constantly updated, and there may be some interference with the analysis of the results. Therefore, further prospective, randomized trials are needed to address these issues. Finally, large-sample randomized controlled studies are still needed to further analyze the impact of various cardiovascular diseases on the perioperative period of colorectal cancer.

Conclusion

Elderly patients with rectal cancer over 75 years old complicated with cardiovascular disease are prone to develop cardiac disorders and anastomotic leakage after radical surgery. For cardiac disorders, adequate preoperative assessment and close postoperative monitoring are the key to ensure that elderly patients with colorectal cancer successfully survive the perioperative period. In addition, for elderly patients with high risk of anastomotic leakage, it can be considered to avoid digestive tract

reconstruction or prophylactic ostomy to reduce the symptoms of anastomotic leakage.

Acknowledgements
None.

Author contributions
Contributions: (I) conception and design: RLN, YJJ, ZBB, WX and WG; (II) administrative support: ZBB, HPZ and JWL; (III) provision of study materials or patients: YJJ, ZBB, HPZ and XHM; (IV) collection and assembly of data: RLN, YJJ and JJB; (V) data analysis and interpretation: YJJ and WG. All authors read and approved the final manuscript.

Funding
This study received funding from the Beijing Hope Run Special Fund of Cancer Foundation of China (LC2022L01).

Data availability
Data can be provided upon reasonable request by email directly sent to the corresponding author.

Declarations

Ethics approval and consent to participate
All enrolled patients sign written informed consent to participate in the study. The study was conducted per STARD reporting guidelines. All the procedures followed the ethical standards of the World Medical Association Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the National Cancer Center/Cancer Hospital, the Chinese Academy of Medical Science, and Peking Union Medical College, and affiliated Heji Hospital of Changzhi Medical College (LA2016-22-01).

Consent for publication
Not applicable.

Conflict of interest
Authors have no conflicts of interest or financial ties to disclose.

Author details
[1]Department of Gastrointestinal Surgery, Affiliated Heji Hospital of Changzhi Medical College, No. 271, Taihang East Street, Changzhi, Shanxi 046011, China
[2]Department of Colorectal Surgery, National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Panjiayuan Nanli No. 17 Courtyard, Chaoyang District, Beijing, China
[3]Department of General Surgery, Hebei Province Hospital of Chinese Medicine, Affiliated Hospital of Hebei University of Chinese Medicine, Changan District, Shijiazhuang, Hebei Province 050013, China

Received: 15 September 2023 / Accepted: 25 July 2024
Published online: 09 August 2024

References

1. Rasool S, Kadla SA, Rasool V, et al. A comparative overview of general risk factors associated with the incidence of colorectal cancer [J]. Tumour Biol. 2013;34(5):2469–76.
2. Ferlay J, Soerjomataram I, Dikshit R, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer. 2015;136(5):E359–86.
3. Arnold M, Sierra MS, Laversanne M, et al. Global patterns and trends in colorectal cancer incidence and mortality[J]. Gut. 2017;66(4):683–91.
4. Heald RJ, Ryall RDH. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;327:1479–82.
5. Taylor FGM, Quirke P, Heald RJ, Moran BJ, Blomqvist L, Swift IR, Sebag-Montefiore D, Tekkis P, Brown G, Magnetic Resonance Imaging in Rectal Cancer European Equivalence Study Group. Preoperative magnetic resonance imaging assessment of circumferential resection margin predicts disease-free survival and local recurrence: 5-year follow-up results of the MERCURY study. J Clin Oncol. 2014;32:34–43.
6. Beets-Tan RGH, Lambregts DMJ, Maas M, Bipat S, Barbaro B, Curvo-Semedo L, Fenlon HM, Gollub MJ, Gourtsoyianni S, Halligan S, et al. Magnetic resonance imaging for clinical management of rectal cancer: updated recommendations from the 2016 European Society of Gastrointestinal and Abdominal Radiology (ESGAR) consensus meeting. Eur Radiol. 2018;28:1465–75.
7. Kapiteijn E, Marijnen CA, Nagtegaal ID, Putter H, Steup WH, Wiggers T, Rutten HJ, Pahlman L, Glimelius B, van Krieken JH, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer. N Engl J Med. 2001;345:638–46.
8. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. Ann Surg. 2009;250(2):187–96.
9. Rahbari NN, Weitz J, Hohenberger W, et al. Definition and grading of anastomotic leakage following anterior resection of the rectum: a proposal by the International Study Group of Rectal Cancer. Surgery. 2010;147:339–51.
10. van Eeghen EE, den Boer FC, Loffeld RJ. Thirty days post-operative mortality after surgery for colorectal cancer: a descriptive study[J]. J Gastrointest Oncol. 2015;6(6):613–7.
11. An Q, Yu T, Cao X, et al. Comparative analysis of postoperative complications on elderly colorectal cancer patients over 65 years with and without comorbid cardiovascular diseases. Zhonghua Wei Chang Wai Ke Za Zhi. 2016;19(9):1035–9.
12. Cramer L, Hildebrandt B, Kung T, et al. Cardiovascular function and predictors of exercise capacity in patients with colorectal cancer[J]. J AM Coll Cardiol. 2014;64(13):1310–9.
13. Mirnezami A, Mirnezami R, Chandrakumaran K, et al. Increased local recurrence and reduced survival from colorectal cancer following anastomotic leak: systematic review and meta-analysis[J]. Ann Surg. 2011;253(5):890–9.
14. Hain E, Maggiori L, Manceau G, et al. Persistent asymptomatic anastomotic leakage after laparoscopic sphincter-saving surgery for rectal cancer: can diverting stoma be reversed safely at 6 months?[J]. Dis Colon Rectum. 2016;59(5):369–76.
15. Rutkowski A, Olesiński T, Zając L, et al. The risk of anastomotic leakage after anterior resection: retrospective analysis of 501 rectal cancer patients operated without protective stoma[J]. Minerva Chir. 2017;72(6):491–8.
16. Tortorelli AP, Alfieri S, Sanchez AM, et al. Anastomotic leakage after anterior resection for rectal cancer with mesorectal excision: incidence, risk factors, and management[J]. Am Surg. 2015;81(1):41–7.
17. Shiomi A, Ito M, Maeda K, et al. Effects of a diverting stoma on symptomatic anastomotic leakage after low anterior resection for rectal cancer: a propensity score matching analysis of 1014 consecutive patients[J]. J Am Coll Surg. 2015;220(2):186–94.
18. Shogan BD, Carlisle EM, Alverdy JC, et al. Do we really know why colorectal anastomoses leak?[J]. J Gastrointest Surg. 2013;17(9):1698–707.
19. Fawcett A, Shembekar M, Church JS, et al. Smoking, hypertension, and colonic anastomotic healing; a combined clinical and histopathological study[J]. Gut. 1996;38(5):714–8.
20. Vignali A, Gianotti L, Braga M, et al. Altered microperfusion at the rectal stump is predictive for rectal anastomotic leak[J]. Dis Colon Rectum. 2000;43(1):76–82.

Publisher's Note