Research article

Study on the effects of intraoperative administration of dexmedetomidine on the prognosis and survival outcomes of patients with colorectal cancer

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ABSTRACT

Background: The perioperative period of tumor surgery commonly utilizes dexmedetomidine as an adjuvant analgesic for anesthesia. Nevertheless, there is a paucity of research investigating its influence on the prognosis of colorectal cancer (CRC). This article primarily aims to examine the correlation between the intraoperative administration of dexmedetomidine and recurrence-free survival (RFS) and overall survival (OS) of colorectal cancer patients, as well as its prognostic implications on survival.

Methods: According to the exclusion criteria, 76 patients undergoing laparoscopic radical resection of CRC under general anesthesia were enrolled at Huizhou Central People's Hospital in 2014. Kaplan-Meier method was used for univariate survival analysis of clinical prognostic factors, RFS, and OS in patients with CRC Cox regression analysis was used for multivariate survival analysis.

Results: A total of 76 patients with CRC were enrolled in this study. Among them, 36 patients were treated with dexmedetomidine (group D), and 40 patients were not treated with dexmedetomidine (group C) during the operation. Survival analysis showed that the RFS and OS of patients in group D were significantly higher than those in group C ($P = 0.046$ and $P = 0.021$, respectively). Multivariate regression analysis demonstrated that the intraoperative administration of dexmedetomidine independently predicted a protective effect on OS ($P = 0.025$).

Conclusions: The intraoperative application of dexmedetomidine as an adjuvant analgesic has a protective effect on the prognosis and survival of patients with CRC and can improve the overall survival rate. Additionally, it influences the recurrence status of patients to a certain extent. These results suggest that dexmedetomidine significantly benefits on the long-term prognosis of patients with CRC.

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1. Introduction

According to statistics, in 2020, colorectal cancer (CRC) ranked second and third globally in cancer incidence and mortality, respectively [1]. In China, research shows that the CRC incidence rate in 2018 was 36.6 per 100,000, significantly higher than the world average of 24.2 per 100,000 [2]. Following the diagnosis of CRC, surgical intervention remains the primary therapeutic approach, where the utilization of distinct anesthesia techniques and pharmacological agents during the surgical procedure may yield varying impacts on the prognosis of patients afflicted with CRC [3–5].

Dexmedetomidine, used as a narcotic adjuvant analgesic and sedative drug, is a specific α2 adrenergic receptor agonist. By inhibiting the release of norepinephrine and affecting the sympathetic nervous system, the drug can reduce the stress response during surgery or anesthesia induction, thereby maintaining hemodynamic stability [6], Consequently, dexmedetomidine finds extensive application in the clinical perioperative setting. In recent years, research reports on dexmedetomidine in tumor cells have emerged. Some studies have shown that dexmedetomidine can promote tumor cell proliferation and metastasis in lung and breast cancer [7–9]. Conversely dexmedetomidine has also been found to inhibit tumor cell proliferation and metastasis in ovarian cancer, esophageal cancer, and osteosarcoma [10–12]. The existing literature on liver cancer cells presents conflicting findings, with some suggesting that dexmedetomidine can both promote and inhibit hepatocellular carcinoma cells [13,14].

Given the varying effects of dexmedetomidine on different types of tumors, this research aims to investigate the specific role of dexmedetomidine on CRC. A retrospective cohort study was conducted to examine the relationship between dexmedetomidine and the prognosis, survival, and development of CRC.

2. Materials and methods

2.1. Case collection

A total of 76 patients with CRC who underwent surgical treatment at Huizhou Central People's Hospital in 2014 were retrospectively collected. Inclusion criteria for this study encompassed the following: (1) Patients undergoing laparoscopic radical resection of CRC under general anesthesia with simple intravenous inhalation, without other nerve block or intraspinal anesthesia. Intravenous analgesia pump (excluding dexmedetomidine) was provided post-surgery; (2) Patients with comprehensive clinical records and available follow-up data; (3) Patients without any cognitive impairment or mental illness; (4) Patients diagnosed with CRC through CT or pathology-based biopsy. Exclusion criteria consisted of: (1) Patients with prior diagnoses of other primary malignant tumors before CRC identification, and those who underwent preoperative and postoperative chemoradiotherapy patients; (2) Patients with incomplete preservation of their case records and those who declined to cooperate during telephone follow-up interviews; (3) Patients with cognitive impairment, psychological disorders, or psychiatric diseases. (4) Patients transferred to intensive care unit after surgery.

2.2. Research design

The selected clinicopathological data that have been selected include the following: (1) Preoperative patient characteristics for radical surgery of CRC, encompassing age, gender, American Society of Anesthesiologists (ASA) classification, serum ferritin, carcinoembryonic antigen(CEA), total cholesterol, low-density lipoprotein, high-density lipoprotein, triglycerides, direct bilirubin, total protein, albumin, total bilirubin, hemoglobin, creatinine, hypertension, and diabetes; (2) Factors related to malignant tumors, such as TNM staging; (3) The utilization of drugs during surgery, such as vasoactive drugs, glucocorticoids, and dexmedetomidine: 1 μg/kg to 100 ml of brine in operation, administered after 0.5 h of slow static drops, and 0.3 μg/kg/h pump injection until half an hour before the end of surgery; (4) The assessment of clinical parameters during surgery, including intraoperative fluid volume, crystalloid and colloid, urine volume, blood loss, blood transfusion, operative time, and surgical excision method. Clinical indexes (total protein, albumin, total bilirubin, direct bilirubin, creatinine, hemoglobin) within one-week post-operation, and cancer markers (carcinoembryonic antigen, serum ferritin) three months after surgery. (5) The time of tumor recurrence and death.

This study followed the principles outlined in the Declaration of Helsinki and received approval from the of Huizhou Central People's Hospital Ethics Committee (approval number: Kyll2023164). All subjects signed informed consent. By telephone follow-up, signed by the patient himself or his family members at the scheduled time. No biological specimens, such as blood and tissue specimens, were used in this study.

2.3. Surgical treatment and follow-up

The patient underwent radical resection of CRC under intravenous inhalation general anesthesia. The operation was performed by an experienced team, with no other nerve block or intraspinal anesthesia administered. All procedures were performed laparoscopically. Follow-up was conducted every three months for the first-year post-surgery, every six months for the second year, and annually thereafter. Follow-up included blood tests and imaging examinations, including serum carcinoembryonic antigen, serum ferritin, at least one imaging examination such as computed tomography (CT), and colonoscopy if necessary. Screening was performed annually using abdominal CT as a standard procedure. Patients were followed until tumor recurrence, death, or the end of the study follow-up on September 1, 2023, Diagnosis of recurrence was based on one of the following criteria: (1) Pathological diagnosis of intestinal tissue or (2) typical manifestations of abdominal enhanced CT (intestinal wall thickening, suspected mass). Recurrence-free survival (RFS) is the interval between the date of first colorectal resection and the date of disease recurrence, death, or last follow-up.

Overall survival (OS) was calculated as the interval from the date of the first colorectal resection until death from any cause or the date of last follow-up.

2.4. Statistical analysis

SPSS 27.0 software was used for data analysis. The chi-square test was used to compare the clinical factors between the groups with and without dexmedetomidine use. The Kaplan-Meier method was used to analyze the relationship between dexmedetomidine and RFS and OS, and the survival curve was drawn. Both univariate and multivariate correlations of each clinical prognostic factor with RFS and OS were analyzed using the Kaplan-Meier method and Cox regression analysis. Survival curves were generated via https://www.bioinformatics.com.cn (the last access time for March 30th, 2024), an online data analysis and visualization platform [15]. All statistical tests in this study were two-sided, and differences were considered statistically significant when $P < 0.05$.

3. Results

3.1. Patient characteristics

From an initial cohort of 101 CRC patients, 25 patients were excluded according to specific criteria, resulting in a final sample size of 76 patients. Among these, 40 cases did not use dexmedetomidine in radical resection of colorectal cancer (group C), while 36 cases used dexmedetomidine (group D) (Fig. 1). The baseline characteristics of the original cohort are presented in Table 1. There were notable variations observed in cholesterol levels ($P = 0.031$) between the two groups. However, there were no significant differences in age, gender, ferritin, carcinoembryonic antigen, total protein, albumin, total bilirubin, direct bilirubin, triglyceride, low density lipoprotein, high density lipoprotein, hemoglobin, ASA classification, hypertension, diabetes, and tumor stage (all $P > 0.05$). In terms of intraoperative and postoperative clinical characteristics, there were no significant differences in the use of intraoperative hormones, vasoactive drugs, operation time, site of surgical resection, blood loss, urine volume, crystalloid fluid volume, colloid fluid volume, blood transfusion, total protein, albumin, total bilirubin, direct bilirubin, hemoglobin, or creatinine (all $P > 0.05$). In the postoperative cancer markers, CEA was significantly different between the two groups ($P = 0.020$) (Table 2).

3.2. Results within the overall cohort

The median RFS time of the whole cohort was 2267 days, with an interquartile range (IQR) of 1346–3263 days, The median OS was 2829 days, with an IQR of 3136–3326 days. During follow-up, tumor recurrence occurred in 23 (57.5 %) of 40 patients in group C and 13 (36.1 %) of 36 patients in group D. The 1 -, 3 -, 5 -, and 9-year RFS rates of group C and group D were 85 %, 72.5 %, 60 %, 45 % and 88.9 %, 83.3 %, 75 %, 63.9 %, respectively. The Kaplan-Meier survival curve shows that group D had higher RFS than group C ($P = 0.046$, Fig. 2A). In terms of OS, 15 of 40 (37.5 %) patients in group D and 5 of 36 (13.9 %) patients in group C died. The 1 -, 3 -, 5 -, and 9-year OS rates of group C and group D were 92.7 %, 82.5 %, 77.5 %, 62.5 % and 100 %, 94.4 %, 88.9 %, 86.1 %, respectively. The Kaplan-Meier survival curve shows that patients in group D ($P = 0.025$, Fig. 2B) had better OS than those in group C.

3.3. Independent prognostic factors for RFS and OS

Predictors of RFS and OS in univariate and multivariate analyses are shown in Table 3. Univariate analysis showed that LDL,
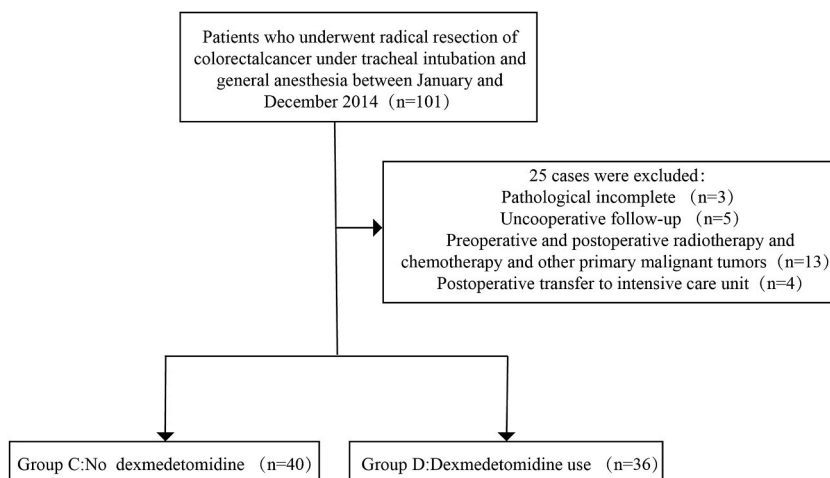

Fig. 1. Patient selection flow chart.

Table 1
Characteristics of patients given dexmedetomidine.

Characteristics	Dexmedetomidine		P-value
	No(n = 40)	Yes(n = 36)	
Age (years)			
≤65	15(37.5 %)	17(47.2 %)	
>65	25(62.5 %)	19(52.8 %)	0.391
Sex			
Female	19(47.5 %)	18(50 %)	
Male	21(52.5 %)	18(50 %)	0.828
Fer(ug/L)			
≤300	37(92.5 %)	34(94.2 %)	
>300	3 (7.5 %)	2 (5.6 %)	0.733
CEA(ug/L)			
≤5	30(75.0 %)	27(75 %)	
>5	10(25.0 %)	9 (25 %)	1.000
TP (g/L)			
≤65	8 (20 %)	8 (22.2 %)	
>65	32(80 %)	28(77.8 %)	0.812
Alb (g/L)			
≤40	28(70 %)	25(69.4 %)	
>40	12(30 %)	11(30.6 %)	0.958
TBIL (μmol/L)			
≤23	40(100 %)	35(97.2 %)	
>23	0 (0 %)	1 (2.8 %)	0.289
DBIL (μmol/L)			
≤8	40(100 %)	35(97.2 %)	
>8	0 (0 %)	1 (2.8 %)	0.289
Cre (μmol/L)			
≤106	37(92.5 %)	35(97.2 %)	
>106	3 (7.5 %)	1 (2.8 %)	0.357
TC (mmol/L)			
≤5.17	29 (72.5 %)	33(91.7 %)	
>5.17	11 (27.5 %)	3 (8.3 %)	**0.031**
TG (mmol/L)			
≤1.7	32(80.0 %)	31(86.1 %)	
>1.7	8 (20.0 %)	5 (13.9 %)	0.480
LDL (mmol/L)			
≤3.1	30(75.0 %)	33(91.7 %)	
>3.1	10(25.0 %)	3 (8.3 %)	0.054
HB (g/L)			
≤120	15(37.5 %)	17(47.2 %)	
>120	25(62.5 %)	19(52.8 %)	0.391
ASA Physical status			
≤2	36(90.0 %)	35(97.2 %)	
>2	4 (10.0 %)	1 (2.8 %)	0.205
HDL (mmol/L)			
≤1.55	34 (85.0 %)	31(86.1 %)	
>1.55	6 (15.0 %)	5 (13.9 %)	0.891
Hypertension			
No	29(72.5 %)	27(75 %)	
Yes	11(27.5)	9 (25 %)	0.805
Diabetes			
No	34(85.0 %)	32(88.9 %)	
Yes	6 (15.0 %)	4 (11.1 %)	0.617
TNM classification[a]			
I/II	25(62.5 %)	13(63.1 %)	
III/IV	15(37.5 %)	13(36.9 %)	0.900

ASA, American Society of Anesthesiologists; Fer, Ferritin; CEA, Carpino embryonic antigen; TP, Total protein; Alb, Albumin; TBIL, Total bilirubin; DBIL, Direct bilirubin; Cre, Creatinine; TC, Total cholesterol; TG, Triglyceride; LDL, Low density lipoprotein; HB, Hemoglobin, High density lipoprotein.

P values of statistical significance are in bold.

[a] Tumor–node–metastasis (TNM) staging was evaluated based on the seventh edition of the American Joint Committee on Cancer (AJCC).

dexmedetomidine and ASA classification were associated with RFS (all $P < 0.05$). Dexmedetomidine and ASA classification significantly influenced overall survival (OS) in patients with CRC ($P < 0.05$). Multivariate analysis showed that LDL (HR: 2.247; 95 % CI: 1.024–4.929; $P = 0.043$) and ASA classification (HR: 3.617; 95 % CI: 1.235–10.590; $P = 0.019$) were important prognostic factors for RFS. Dexmedetomidine (HR: 0.309; 95 % CI: 0.111–0.862; $P = 0.025$) and ASA classification (HR: 3.900; 95 % CI: 1.133–13.429; $P =$

Table 2

Intraoperative and postoperative clinical characteristics of patients in without and with dexmedetomidine.

Characteristics	Dexmedetomidine		P-value
	No(n = 40)	Yes(n = 36)	
Intraoperative crystalline fluid	1512.50 ± 430.97	1583.33 ± 638.08	0.562
Intraoperative colloid volume	1050.78 ± 272.69	1069.44 ± 380.84	0.782
Duration of operation (minutes)	220.86 ± 69.48	214.31 ± 67.99	0.834
Blood loss(ml)	120.50 ± 110.97	98.89 ± 76.49	0.340
Intraoperative urine output(ml)	688.75 ± 567.55	727.78 ± 669.16	0.750
Blood transfusion			
No	37(92.5 %)	31(86.1 %)	
Yes	3(7.5 %)	5(13.9 %)	0.365
Colorectal resection			
left Colectomy	2 (5.0 %)	2 (5.6 %)	
right Colectomy	7 (17.5 %)	15(41.7 %)	
Proctectomy	31(77.5 %)	19(52.8 %)	0.061
Postoperative TP (g/L)			
≤65	34(85.0 %)	32(88.9 %)	
>65	6 (15.0 %)	4 (11.1 %)	0.617
Postoperative Alb (g/L)			
≤40	41(100 %)	34(94.4 %)	
>40	0 (0 %)	2 (5.6 %)	0.131
Postoperative TBIL (µmol/L)			
≤23	39(97.5 %)	36(100 %)	
>23	1 (2.5 %)	0 (0 %)	0.340
Postoperative DBIL (µmol/L)			
≤8	39(97.5 %)	35(97.2 %)	
>8	1 (2.5 %)	1 (2.8 %)	0.940
Postoperative Cre (µmol/L)			
≤106	36(90.0 %)	36(100 %)	
>106	4 (10.0 %)	0 (0 %)	0.051
Postoperative HB (g/L)			
≤120	30(75.0 %)	29(80.6 %)	
>120	10(25.0 %)	7 (19.4 %)	0.562
Glucocorticoid			
No	34(85.0 %)	25(69.4 %)	
Yes	6 (15.0 %)	11(30.6 %)	0.104
Vasoactive drugs			
No	27(67.5 %)	26(72.2 %)	
Yes	13(32.5 %)	10(27.8 %)	0.655
Postoperative CEA(ug/L)			
≤5	30(75.0 %)	34(94.4 %)	
>5	10(25.0 %)	2 (15.6 %)	**0.020**
Postoperative Fer(ug/L)			
≤300	36(90.0 %)	31(86.1 %%)	
>300	4 (10.0 %)	9 (11.7 %)	0.600

P values of statistical significance are in bold.

TP, Total protein; Alb, Albumin; TBIL, Total bilirubin; DBIL, Direct bilirubin; Cre, Creatinine; HB, Hemoglobin; Fer, Ferritin; CEA, Carpino embryonic antigen.

0.031) were independent prognostic factors for OS.

4. Discussion

This study is the first to evaluate the effect of intraoperative dexmedetomidine as an adjuvant analgesic on long-term survival in patients with CRC. For the first time since the introduction of dexmedetomidine into clinical practice, the long-term association between dexmedetomidine and the prognosis of CRC was analyzed. This study found that intraoperative administration of dexmedetomidine was an independent protective factor for prognosis. These findings suggest that the use of dexmedetomidine in CRC surgery can prolong OS. Although the multivariate analysis did not find a significant effect on RFS, possibly due to the small sample size or biases in the study, the relevant data suggest that dexmedetomidine may be a potentially beneficial intraoperative medication. In the univariate analysis of OS (Table 3), total protein ($P = 0.045$) was correlated with OS, while vasoactive drugs ($P = 0.085$) and hypertension ($P = 0.059$) were not statistically significant but suggest higher total protein levels and less use of vasoactive drugs during the operation could improve OS. The prognosis of CRC patients without hypertension may be better, indicating that the initial data of this study align more closely with the real clinical scenario and possess a certain level of credibility.

Dexmedetomidine, as a commonly used adjuvant sedative and analgesic drug, is coordinated with opioids to reduce their dosage and the dose-dependent adverse reactions [16]. It is widely used in clinical practice, as is CRC surgery. Nevertheless, the surgical-induced tissue trauma and the ensuing pain-induced stress response trigger a sustained inflammatory reaction within the
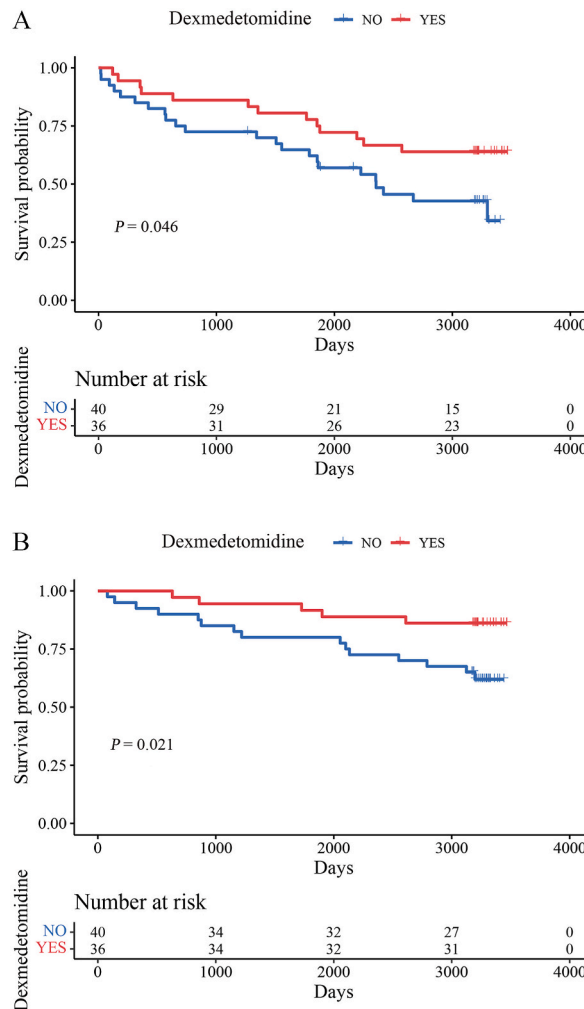
Fig. 2. Recurrence-free survival (RFS) and overall survival (OS) curves of colorectal cancer patients with and without dexmedetomidine. (A) RFS curves. (B) OS curves.

body, and induce immune hyperfunction [17].Therefore, reducing the perioperative stress response can alleviate the body's immunosuppression and improve the postoperative recovery of patients [18]. In the short term, the possible mechanism by which dexmedetomidine affects the prognosis of CRC is by regulating the immune function, inflammatory state and stress response of tumor patients [19]. Some scholars have found that the use of dexmedetomidine reduces postoperative systemic inflammatory response and immune dysfunction, which can also reduce the incidence of postoperative cognitive dysfunction in patients with gastrointestinal cancer surgery [20]. Other scholars have found that dexmedetomidine inhibits the release of sympathetic inflammatory cytokines through the cholinergic pathway [21]. Including in vitro experiments, animal studies have found that dexmedetomidine down-regulates the expression of inflammatory factors TNF-α, IL-1β, and IL-6, and reduces intestinal mucosal injury in rats [22]. In the long term, one of the mechanisms by which dexmedetomidine affects the prognosis of CRC may be organ protection. Some studies have found that dexmedetomidine has a protective effect on intestinal ischemia reperfusion through different pathways and avoids intestinal injury [23,24]. In addition, dexmedetomidine has a protective effect on important organs, such as brain [25], heart [26], kidney [27] and lung [28]. The protective effect of these organs, especially on intestinal tract, is conducive to maintaining body homeostasis, which may be a potential protective factor for the effect of dexmedetomidine on the prognosis of CRC. Another long-term effect on prognosis of CRC may be the potent potency of dexmedetomidine as an α2-adrenergic receptor agonist Antitumor activity. Recently, researchers have found that α2 adrenergic receptor agonists such as clonidine have strong antitumor activity in a variety of immune tumor models, which can greatly improve the clinical efficacy of tumor immunotherapy [29]. Dexmedetomidine, as a more affinity α2 receptor agonist than clonidine, should have a stronger anti-tumor effect. This may also be one of the direct factors affecting the long-term prognosis and recurrence of dexmedetomidine.

This study shows that dexmedetomidine can improve the overall survival rate of patients with CRC to a certain extent. Some scholars have explored the relationship between the perioperative use of dexmedetomidine and the prognosis of patients, and the results found that the perioperative use of dexmedetomidine can reduce the postoperative mortality of patients undergoing cardiac

Table 3

Univariate and multivariate analysis of patient RFS and OS.

Variables	RFS			OS		
	Univariate	Multivariable Analysis		Univariate	Multivariable Analysis	
	P	HR (95 % CI)	P	P	HR (95 % CI)	P
Sex						
Female						
Male	0.109			0.224		
Age (y)						
≤50						
>50	0.167			0.214		
Dexmedetomidine						
No						
Yes	**0.046**	0.573(0.285–1.152)	0.118	**0.021**	0.309(0.111–0.862)	**0.025**
Fer(ug/L)						
≤300						
>300	0.134			0.410		
CEA(ug/L)						
≤5						
>5	0.831			0.304		
TP (g/L)						
≤65						
>65	0.231			**0.045**	0.484(0.172–1.339)	0.161
Alb (g/L)						
≤40						
>40	0.717			0.258		
TBIL (μmol/L)						
≤23						
>23	0.255			0.132		
DBIL (μmol/L)						
≤8						
>8	0.424			0.577		
Cre (μmol/L)						
≤106						
>106	0.473			0.941		
Surgical site						
left colon						
right colon						
rectum	0.508			0.394		
LDL (mmol/L)						
≤3.1						
>3.1	**0.026**	2.247(1.024–4.929)	**0.043**	0.162		
TC (mmol/L)						
≤5.17						
>5.17	0.133			0.806		
HDL (mmol/L)						
≤1.55						
>1.55	0.908			0.599		
TG (mmol/L)						
≤1.7						
>1.7	0.957			0.368		
HB (g/L)						
≤120						
>120	0.716			0.188		
ASA physical status						
≤2	**0.023**	3.617(1.235–10.590)	**0.019**	**< 0.01**	3.900(1.133–13.429)	**0.031**
>2						
Hypertension						
No						
Yes	0.297			0.059		
Glucocorticoid						
No						
Yes	0.321			0.326		
Vasoactive drugs						
No						
Yes	0.463			0.085		
Diabetes						
No						
Yes	0.230			0.745		
TNM classificatio[a]						

Table 3 (*continued*)

Variables	RFS			OS		
	Univariate	Multivariable Analysis		Univariate	Multivariable Analysis	
	P	HR (95 % CI)	P	P	HR (95 % CI)	P
I/II						
III/IV	0.593			0.100		
Blood transfusion						
No						
Yes	0.950			0.949		
Duration of operation (minutes)						
≤240						
>240	0.997			0.724		

P values of statistical significance are in bold.
ASA, American Society of Anesthesiologists; Fer, Ferritin; CEA, Carpino embryonic antigen; TP, Total protein; Alb, Albumin; TBIL, Total bilirubin; DBIL, Direct bilirubin; Cre, Creatinine; TC, Total cholesterol; TG, Triglyceride; LDL, Low density lipoprotein; HB, Hemoglobin, High density lipoprotein.
  [a] Tumor–node–metastasis (TNM) staging was evaluated based on the seventh edition of the American Joint Committee on Cancer (AJCC).

surgery and reduce the rate of delirium [30]. Consistent with this study, both are beneficial to the prognosis of patients. However, as this study is a retrospective study, there are still many disadvantages. First, as a single-center study, the sample size is small. And due to changes in our hospital information system, we were unable to provide a longer time span and a larger sample size. In the future, larger sample size or multi-center studies are needed, and further prospective studies should be conducted to verify and improve and support the conclusions of this study. Second, there are many factors that affect the prognosis of cancer patients that we can't fully collect. For example, postoperative pain and postoperative complications affect the prognosis of cancer [31,32]. Cancer patients' psychological social factors, if they have a positive attitude to their prognosis, be helpful for prognosis, and the doctor and patient preference for prognostic information related characteristics [33]. These factors are considered as potential factors affecting cancer recurrence and prognosis [34]. Moreover, there are some confounding factors that are difficult to control, such as individual differences between patients in the observation group and the control group, which make this study have certain limitations.

5. Conclusion

This study analyzed the effect of intraoperative dexmedetomidine as an adjuvant analgesic on long-term survival outcomes of CRC. It found that patients who received intraoperative dexmedetomidine had better OS and may improve the recurrence-free survival rate of patients. The specific mechanism needs further study.

Ethics approval and consent to participate

This study was conducted in compliance with the principles outlined in the Declaration of Helsinki and received approval from the Ethics Committee of Huizhou Central People's Hospital (Approval Number: Kyll2023164). All subjects signed informed consent. No biological specimens, such as blood and tissue specimens, were used in this study.

Consent for publication

All authors agree to the publication of this manuscript.

Data availability

Original data of this clinical study data have been deposited at Research Data Deposit (RDD) (https://www.researchdata.org.cn/default.aspx) with accession numbers RDDAG2024696430.

Funding information

CRediT authorship contribution statement

Chu Ren: Writing – original draft, Investigation, Data curation. **Ying Zeng:** Investigation. **Liuji Qiu:** Supervision, Resources. **Dexing Luo:** Supervision, Resources. **Junfang Wang:** Writing – original draft, Validation, Conceptualization. **Xin Chen:** Writing – original draft, Validation, Methodology, Conceptualization. **Yan Yan:** Writing – review & editing, Project administration.

Declaration of competing interest

Acknowledgement

Abbreviations

RFS	recurrence-free survival
OS	overall survival
ASA	American Society of Anesthesiologists
Fer	Ferritin
CEA	Carcinoembryonic antigen
TP	Total protein
Alb	Albumin
TBIL	Total bilirubin
DBIL	Direct bilirubin
Cr	Creatinine
TC	Total cholesterol
TG	Triglyceride
LDL	Low density lipoprotein
HB	Hemoglobin
HDL	High density lipoprotein
TNM	Tumor–Node–Metastasis

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