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Short-term outcomes of open versus laparoscopic surgery in patients with metachronous colorectal cancer

Jiyun Li[1], Ruoxi Tian[1], Hengchang Liu[1], Haipeng Chen[1*] and Zhaoxu Zheng[1*]

Abstract

Background Few studies have assessed the safety and efficacy of laparoscopic surgery in patients with metachronous colorectal cancer (MCRC). This study aims to evaluate the safety and outcomes of laparoscopic surgery in MCRC patients who have previously undergone colorectal cancer surgery.

Methods We compared the short-term outcomes of open versus laparoscopic surgery in patients with MCRC between October 2007 and October 2022.

Results Among the 59 MCRC patients, 25 underwent laparoscopic surgery, whereas 34 received open surgery. The proportion of patients who underwent prior open surgeries was significantly greater in the open group than in the laparoscopic group (91.2% vs. 24.0%, $p < 0.001$). Three patients (12.0%) in the laparoscopic group required conversion to laparotomy due to severe intra-abdominal adhesions, all of whom had a history of open surgery for colorectal cancer. Compared to the open surgery group, the laparoscopic group presented significantly less estimated blood loss (56.80 ± 115.47 vs. 136.47 ± 158.61 ml, $p = 0.038$), a shorter time to the first flatus (2.20 ± 0.76 vs. 3.50 ± 0.62 days, $p < 0.001$), a shorter time to the first stool (2.92 ± 0.64 vs. 4.32 ± 0.64 days, $p < 0.001$), and a shorter postoperative hospitalization duration (7.24 ± 2.42 vs. 10.79 ± 3.50 days, $p < 0.001$).

Conclusion Laparoscopic surgery for MCRC patients is a safe and less invasive alternative to open surgery, resulting in reduced estimated blood loss, faster recovery of bowel function, and shorter postoperative hospitalization.

Keywords Metachronous colorectal cancer, Laparoscopic surgery, Open surgery, Short-term outcomes

Introduction

Since its introduction by Jacobs et al. in 1991, laparoscopic colorectal surgery has become the preferred surgical method for treating colorectal cancer [1]. Extensive randomized controlled trials (RCTs) over the past three decades have consistently attested to its safety and effectiveness [2–7]. Compared to open surgery, laparoscopic procedures are associated with reduced postoperative discomfort, quicker restoration of intestinal function, and shorter hospital stays. Moreover, numerous studies have underscored the efficacy of laparoscopic colorectal resection in terms of curative outcomes and long-term prognosis. Consequently, laparoscopic surgery has emerged as a widely accepted approach for colorectal cancer treatment.

Metachronous colorectal cancer (MCRC) refers to the occurrence of a second primary colorectal cancer following the initial diagnosis, with a minimum

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interval of 6 months between occurrences [8]. While medical advancements have notably improved the prognosis of patients with colorectal cancer, the risk of MCRC increases with increasing postsurgical survival duration [9]. As a result, the number of secondary colorectal resections for MCRC may increase in the future. Achieving radical resection, including lymph node dissection, remains crucial for treating MCRC. Nevertheless, this procedure can be intricate because of factors such as intraperitoneal adhesions, anatomical layer obliteration, and compromised blood flow.

Despite these considerations, studies specifically evaluating the safety and efficacy of laparoscopic surgery for MCRC are lacking. This study is unique in its focus on MCRC patients, a subset of colorectal cancer patients who has not been sufficiently explored in existing research. By comparing laparoscopic and open surgery, this research aims to contribute novel insights into surgical strategies and outcomes for this patient group.

Methods

Patients

Patients diagnosed with MCRC in this study followed a structured diagnostic and therapeutic pathway. Initially, they present at outpatient clinics with symptoms prompting a series of diagnostic investigations, including blood tests, imaging studies, and digestive endoscopy with biopsy. Based on the results, a multidisciplinary team—including specialists in gastroenterology, oncology, radiology, and surgery—reviewed each case. The team collaboratively decided on the most appropriate therapeutic approach for each patient, ensuring a personalized treatment plan. This retrospective study included patients who underwent secondary colorectal resection for MCRC via either laparoscopic or open approaches at our institution between October 2007 and October 2022. We carefully reviewed their medical history to ensure that they met the following inclusion criteria: a minimum of six months from their initial colorectal cancer diagnosis, evidence of a second primary colorectal tumor, and no other significant medical conditions that would interfere with the surgery. The exclusion criteria included synchronous multiple primary cancers requiring resection at multiple sites, emergent cases, palliative or transanal excisions, and concurrent additional surgical procedures (e.g., liver resection). Recurrent tumors were excluded by confirming the absence of recurrence through clinical evaluation, imaging studies (such as CT scans and colonoscopy), and pathology reports, including multidisciplinary discussions to rule out metastasis or recurrence of the original tumor. Only patients with a clear diagnosis of a second primary colorectal cancer, confirmed through pathological examination, were included in the study. Patients were categorized into laparoscopic or open surgery groups based on the surgical approach.

This study was approved by the Institutional Review Board Committee of the Cancer Hospital, Chinese Academy of Medical Sciences and individual consent for this retrospective analysis was waived. Patient data were collected from the clinical reports of our institution. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) [10].

Clinical characteristics and parameters

Extensive clinical data, including patient demographics (gender, age at surgery, body mass index [BMI]), American Society of Anesthesiologists (ASA) classification score, year of surgery, type of previous operation, history of other abdominal surgery, interval between operations, tumor characteristics (location, size, gross classification, differentiation, Union for International Cancer Control [UICC] TNM stage), and preoperative chemotherapy and radiotherapy, were meticulously reviewed. Intraoperative and postoperative parameters, including surgical procedure type, operation duration, estimated blood loss, harvested lymph nodes, resection margin, conversion to laparotomy, resection at the previous anastomotic site, anus-preserving operation, time to first flatus, time to first stool, postoperative complications, hospitalization duration, and mortality, were compared between the laparoscopic and open surgery groups.

Surgical procedures

All procedures were performed by specialized colorectal surgeons with extensive experience in more than 300 colorectal surgeries. The choice between laparoscopic and open surgery was made at the discretion of the surgical team. The decision to perform laparoscopic or open surgery was influenced by preoperative patient factors, including tumor location, size, prior surgery, and surgeon expertise. For laparoscopic procedures, a 10-mm umbilical port served as the camera port, with a 12-mm port for the surgeon's right hand and three 5-mm ports for the surgeon's left hand and both assistant's hands. Open colorectal resections were executed through a midline laparotomy. Conversion to open surgery was defined as a deviation from the initially planned laparoscopic procedure, and all patients, including those who required conversion to open surgery, were analyzed according to the intention-to-treat principle. Specifically, patients who required conversion to open surgery were included in the laparoscopic group for statistical purposes.

Perioperative management

Uniform perioperative management was implemented for both groups, including bowel preparation, prophylactic antibiotics, pain control utilizing opioid-based patient-controlled analgesia and nonsteroidal anti-inflammatory drugs, removal of urinary catheters on postoperative day 2 or 3, initiation of oral intake within 3 days postsurgery, and removal of the abdominal drainage tube approximately 5 days postsurgery in the absence of anastomotic leakage. The discharge criteria included meal tolerance, passage of flatus and stool, adequate pain control, and independent ambulation.

Statistical analyses

Comparisons between groups were performed for patient characteristics, operative findings, and postoperative outcomes. Continuous variables were expressed as the means ± standard deviations (SDs) and were analyzed using the Mann–Whitney U test or t test. Categorical variables were presented as frequencies and percentages and were analyzed using the chi-square test or Fisher's exact probability test. Statistical significance was set at $p < 0.05$. Data analysis was conducted using SPSS software version 21.0 (IBM Inc., Armonk, NY, USA). The study adhered to the STROBE reporting recommendation.

Results

A total of 59 patients diagnosed with MCRC, comprising 41 males and 18 females, were included in this retrospective study. Table 1 displays the clinical disparities between patients with prior and metachronous colorectal cancer. Surgeries for prior colorectal cancer were distributed across three periods—1980–2010, 2010–2020, and 2020—to the present, with 53% of the resections conducted at other institutions. The locations of the previous and metachronous tumors were similar. Among these patients, 37 underwent laparotomy, whereas 22 underwent laparoscopic surgery for prior colorectal cancer. Figure 1 illustrates the sites of prior and metachronous colorectal cancers. Among patients with prior resections in the right-sided colon, left-sided colon, and rectum, secondary surgeries in the same area were observed in 2 of 16 cases, 5 of 21 cases, and 4 of 22 cases, respectively.

Among the 59 MCRC patients, 25 underwent laparoscopic surgery, and 34 received open surgery. The mean age of the patients was 61.56 ± 12.75 years. Table 2 presents the demographic and clinicopathologic characteristics of both groups. No significant differences were observed in gender, age at surgery, BMI, ASA score, year of surgery, history of other abdominal surgery, interval between surgeries, tumor characteristics, differentiation, or TNM stage. Although not statistically significant, tumor size tended to be larger in the open surgery group than in the laparoscopic group (4.31 ± 3.03 vs. 3.11 ± 1.68 cm, $p = 0.078$). Notably, a significantly greater percentage of prior open surgeries was observed in the open surgery group (91.2% vs. 24.0%, $p < 0.001$).

Table 1 Differences between operations for previous colorectal cancers and metachronous colorectal cancers

	Previous colorectal cancers ($n = 59$)	Metachronous colorectal cancers ($n = 59$)
Age at surgery (years), mean ± SD	53.78 ± 13.89	61.56 ± 12.75
Period of operation (%)		
1980–2010	28	2
2010–2020	30	51
2020	1	6
Institution (%)		
Our institution	28	59
Other institutions	31	0
Type of operation (%)		
Open surgery	37	34
Laparoscopic surgery	22	25
Location (%)		
Right colon	16	16
Left colon	21	16
Rectum	22	27

Table 3 summarizes the short-term outcomes. No significant differences were noted between the open and laparoscopic groups in terms of the operative procedure, operative time (194.71 ± 83.46 vs. 195.44 ± 76.54 min, $p = 0.973$), harvested lymph nodes (22.56 ± 15.78 vs. 24.40 ± 24.66, $p = 0.728$), anus-preservation rate (70.6% vs. 68.0%, $p = 1.000$), or rate of postoperative complications (20.6% vs. 16.0%, $p = 0.913$). However, estimated blood loss was significantly lower in the laparoscopic group than in the open group (56.80 ± 115.47 vs. 136.47 ± 158.61 ml, $p = 0.038$). Although not statistically significant, a lower proportion of patients in the laparoscopic group required resection at a previous anastomotic site (24.0% vs. 32.4%). In the laparoscopic group, three patients (12.0%) required conversion to laparotomy due to severe intra-abdominal adhesion, all of whom had previously undergone open surgery for colorectal cancer. Compared to the open surgery group, the laparoscopic group presented significantly shorter durations for time to first flatus (2.20 ± 0.76 vs. 3.50 ± 0.62 days, $p < 0.001$), time to first stool (2.92 ± 0.64 vs. 4.32 ± 0.64 days, $p < 0.001$), and postoperative hospitalization (7.24 ± 2.42 vs. 10.79 ± 3.50 days, $p < 0.001$). Complete R0 resection was achieved in all patients, and no mortality was observed in either group.

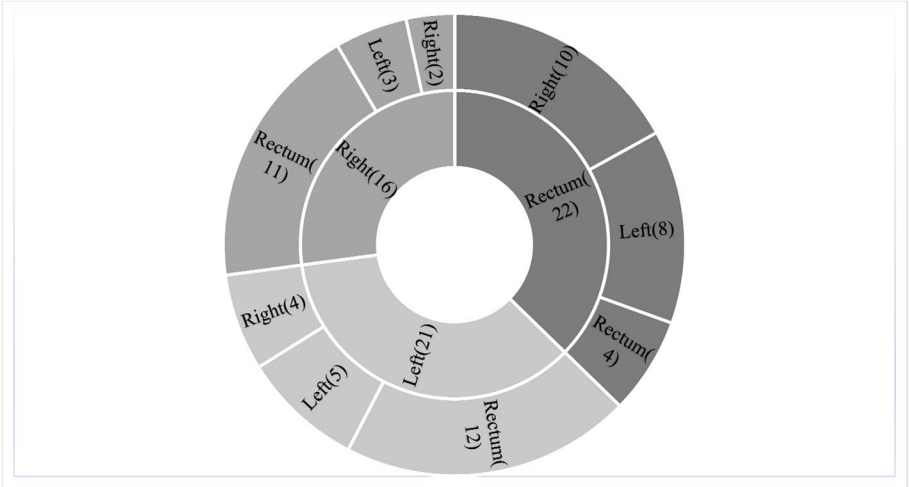

Fig. 1 The resection areas of previous colorectal cancers and metachronous colorectal cancers. The pie chart shows the resection area of previous colorectal cancers and metachronous colorectal cancers. The inner circle shows the resection area of the previous surgery, and the outer circle shows the resection area of the secondary surgery

Discussion

Laparoscopic surgery has demonstrated superiority over laparotomy in terms of short-term outcomes, as evidenced by several RCTs, and has gained increasing popularity for colorectal cancer surgeries worldwide [4, 6]. However, the existing body of RCTs on laparoscopic colorectal cancer surgery remains limited, particularly in evaluating outcomes for MCRC patients who underwent laparoscopic surgery after previous colorectal cancer resections. Therefore, a comprehensive assessment of the safety and efficacy of laparoscopic colorectal cancer surgery in this specific patient cohort compared with those of open surgery is warranted.

Studies specifically comparing the short-term outcomes of laparoscopic surgery in patients with MCRC are scarce. For example, Nagasaki et al. evaluated perioperative outcomes in 26 patients who underwent laparoscopic surgery and 26 who underwent open surgery for MCRC and reported significantly lower blood loss, faster gastrointestinal recovery, and shorter hospital stays in the laparoscopic group [11]. However, their study did not exclude three patients with synchronous colorectal cancer. In a 2023 retrospective observational study by Jun Sakai et al., a matched case–control analysis of redo laparoscopic colorectal resection (Re-LCRR) in 29 patients versus primary laparoscopic colorectal resection in 58 patients revealed that the Re-LCRR was a safe procedure without increased postoperative complications or prolonged hospital stays compared to the initial LCRR [12]. Nevertheless, their study also included patients with benign conditions such as benign tumors and diverticulosis of the colon.

To our knowledge, this study presents the most extensive investigation to date aimed at delineating the safety of laparoscopic surgery in patients with MCRC through a direct comparison of short-term outcomes with those of patients who underwent open surgery. Consistent with previous reports comparing laparoscopic and open surgery in patients with MCRC [11, 13], our findings indicate a significant reduction in estimated blood loss, increased recovery of bowel function, and a shorter duration of postoperative hospitalization within the laparoscopic surgery group. Furthermore, crucial parameters, such as the operative procedure, duration, lymph node retrieval, preservation of anal function, and incidence of postoperative complications, exhibited comparable outcomes between the laparoscopic and open surgery cohorts in our study. Notably, the similar operative times between laparoscopic and open surgeries in our study may reflect selection bias toward less complex cases for laparoscopic surgery.

In our study, laparoscopic surgery was performed on 25 patients with MCRC, among whom three patients (12.0%) necessitated conversion to open surgery due to severe intra-abdominal adhesions. While our observed conversion rate aligns with prior studies involving patients with MCRC, it notably surpassed the 7.7% conversion rate reported by Nagasaki et al. [11]. This higher conversion rate in our study may be attributed to the relatively greater complexity of laparoscopic surgeries undertaken for MCRC. Previous investigations of laparoscopic colorectal cancer surgery in patients with a history of abdominal surgery have reported conversion rates ranging from 14.5% to 26.1% [14]. Notably,

Table 2 Demographic and clinicopathologic characteristics of the patients who underwent open and laparoscopic surgery

	Open surgery (*n* = 34)	**Laparoscopic surgery (*n* = 25)**	***P* value**
Gender (%)			0.284
Male	26 (76.5)	15 (60.0)	
Female	8 (23.5)	10 (40.0)	
Age at surgery (years), mean ± SD	61.26 ± 12.00	61.96 ± 13.95	0.838
BMI (kg/m^2), mean ± SD	24.87 ± 3.69	23.98 ± 2.71	0.313
ASA score (%)			0.184
II	25 (73.5)	23 (92.0)	
III	8 (23.5)	2 (8.0)	
IV	1 (2.9)	0 (0.0)	
Year of surgery (%)			0.229
1980–2010	2 (5.9)	0 (0.0)	
2010–2020	30 (88.2)	21 (84.0)	
2020-present	2 (5.9)	4 (16.0)	
Type of previous operation (%)			< 0.001
Open surgery	31 (91.2)	6 (24.0)	
Laparoscopic surgery	3 (8.8)	19 (76.0)	
History of other abdominal surgery (%)			0.222
No	26 (76.5)	23 (92.0)	
Yes	8 (23.5)	2 (8.0)	
Preoperative chemotherapy(%)			0.619
No	17 (50.0)	15 (60.0)	
Yes	17 (50.0)	10 (40.0)	
Preoperative radiotherapy(%)			1.000
No	28 (82.4)	21 (84.0)	
Yes	6 (17.6)	4 (16.0)	
Interval between operations (months), mean ± SD	92.65 ± 103.50	94.68 ± 114.76	0.943
Tumor location (%)			0.375
Right colon	11 (32.4)	5 (20.0)	
Left colon	10 (29.4)	6 (24.0)	
Rectum	13 (38.2)	14 (56.0)	
Tumor size (cm), mean ± SD	4.31 ± 3.03	3.11 ± 1.68	0.078
Gross classification (%)			0.115
Mass type	24 (70.6)	15 (60.0)	
Ulceration type	7 (20.6)	10 (40.0)	
Infiltration type	3 (8.8)	0 (0.0)	
Differentiation (%)			1.000
p/d	8 (23.5)	6 (24.0)	
w/d, m/d	26 (76.5)	19 (76.0)	
T stage (%)			0.121
1	6 (17.6)	9 (36.0)	
2	5 (14.7)	7 (28.0)	
3	13 (38.2)	5 (20.0)	
4	10 (29.4)	4 (16.0)	
N stage (%)			0.414
0	25 (73.5)	15 (60.0)	

Table 2 (continued)

	Open surgery (*n* = 34)	Laparoscopic surgery (*n* = 25)	*P* value
1,2	9 (26.5)	10 (40.0)	
M stage (%)			NA
0	34 (100.0)	25 (100.0)	
1	0 (0.0)	0 (0.0)	
TNM stage (%)			0.414
I,II	25 (73.5)	15 (60.0)	
III	9 (26.5)	10 (40.0)	

SD Standard deviation, *BMI* Body mass index, *ASA Score* American Society of Anesthesiologists classification score, *p/d* Poorly differentiated, *w/d* Well differentiated, *m/d* Moderately differentiated, *NA* Not applicable

all patients requiring conversion to open surgery in our study had previously undergone open surgery for colorectal cancer. Additionally, we observed a significantly greater proportion of prior open surgeries in the open surgery group than in the laparoscopic group (91.2% vs. 24.0%, $p < 0.001$). These findings underscore the criticality of meticulous case selection and extensive experience in ensuring successful laparoscopic surgery for MCRC.

During the second operation for MCRC, determining the extent of bowel resection, particularly whether to encompass the previous anastomotic site, can pose challenges. For example, if the root of the inferior mesenteric artery was previously divided, further dissection during surgery for transverse colon cancer might compromise the blood supply to the left colon, necessitating resection of an extended portion of the left colon, including the previous anastomotic site. In our cohort, six out of 25 patients (24.0%) in the laparoscopic group and eleven out of 34 patients (32.4%) in the open group underwent colorectal resection that involved the previous anastomotic site. Moreover, the thoroughness of resection, assessed by the number of harvested lymph nodes and the rate of negative resected proximal and distal margins, showed no discernible differences between the groups. These collective findings support the feasibility of performing radical laparoscopic surgery for MCRC.

Furthermore, nutritional status and adherence to enhanced recovery after surgery (ERAS) protocols are critical for improving short-term outcomes in MCRC patients. Malnutrition adversely affects postoperative recovery, increases complications, and prolongs hospitalization, whereas preoperative nutritional support enhances recovery and reduces risks. ERAS protocols, which incorporate optimized nutrition, reduced surgical stress, and early mobilization, have demonstrated efficacy in accelerating recovery and shortening hospital stays [15]. Moreover, the gentleness of the surgical approach, facilitated by advanced energy-based techniques, plays a significant role in minimizing tissue trauma and enhancing recovery. Experience and the high volume of work at specialized centers further contribute to improved surgical precision and better perioperative outcomes [16]. Integrating nutritional support, ERAS protocols, and the expertise of high-volume centers with advanced surgical techniques optimizes both short- and long-term results, emphasizing the importance of a multidisciplinary approach.

Several limitations accompany the analysis presented in this study. The retrospective nature of this investigation, which was conducted at a single institution, rather than a large-scale multicenter randomized trial, led to a small sample size. As a result, the small sample size may have increased the likelihood of type II errors, where true effects could not be detected owing to insufficient statistical power. Given the statistical nature of hypothesis testing, all reported statistical outcomes carry a probability of inducing both type I and type II errors. Increasing the sample size would help mitigate these errors and provide more robust statistical conclusions. The single-institution design also limits the external validity of our findings, and future studies with larger, multicenter cohorts would be necessary to confirm the generalizability of the results. Another potential source of bias in our study lies in the surgeon's individual decision on the surgical approach. The choice between laparoscopic and open surgery was made based on the surgeon's clinical judgment and experience, which may have influenced the selection process and the outcomes observed. While we attempted to minimize this bias by including only patients who met the inclusion criteria, the lack of randomization remains a significant limitation. Future prospective studies with randomized surgical approach allocation are essential to eliminate this confounding factor and strengthen the evidence base. Furthermore, the duration of follow-up in our study was insufficient to comprehensively assess the long-term outcomes of open versus laparoscopic surgery

Table 3 Short-term outcomes (open vs. laparoscopic surgery)

	Open surgery ($n=34$)	Laparoscopic surgery ($n=25$)	*P* value
Operative procedures (%)			0.716
Abdominoperineal resection	4 (11.8)	2 (8.0)	
Anterior resection	3 (8.8)	7 (28.0)	
Hartmann	5 (14.7)	4 (16.0)	
Left hemicolectomy	5 (14.7)	2 (8.0)	
Right hemicolectomy	10 (29.4)	5 (20.0)	
Sigmoidectomy	1 (2.9)	1 (4.0)	
Subtotal or total colectomy	2 (5.9)	1 (4.0)	
Transverse colectomy	4 (11.8)	3 (12.0)	
Intraoperative parameters			
Operation time (min), mean ± SD	194.71 ± 83.46	195.44 ± 76.54	0.973
Estimated blood loss (mL), mean ± SD	136.47 ± 158.61	56.80 ± 115.47	0.038
Number of harvested lymph nodes	22.56 ± 15.78	24.40 ± 24.66	0.728
Proximal margin, distal margin			NA
Negative	34	25	
Positive	0	0	
R stage			NA
R0	34	25	
R1/2	0	0	
Conversion to laparotomy	NA	3 (12.0%)	NA
Resection at previous anastomotic site	11 (32.4%)	6 (24.0%)	0.682
Anus-preservation operation	24 (70.6%)	17 (68.0%)	1.000
Postoperative parameters			
Time to first flatus (days), mean ± SD	3.50 ± 0.62	2.20 ± 0.76	< 0.001
Time to first stool (days), mean ± SD	4.32 ± 0.64	2.92 ± 0.64	< 0.001
Overall complication	7(20.6%)	4 (16.0%)	0.913
Surgical site infection	3 (8.8%)	1 (4.0%)	0.838
Ileus	2 (5.9%)	0 (0.0%)	0.613
Enterocolitis	2 (5.9%)	1 (4.0%)	1.000
Anastomotic site bleeding	0 (0.0%)	1 (4.0%)	0.876
Anastomotic leakage	0 (0.0%)	1 (4.0%)	0.876
Postoperative hospitalization time (days), mean ± SD	10.79 ± 3.50	7.24 ± 2.42	< 0.001
Mortality	0 (0.0%)	0 (0.0%)	NA

NA Not applicable

in patients with MCRC. Further studies with a randomized controlled design, adequate sample size, long-term follow-up, and more than one center are needed to confirm the long-term outcomes.

Conclusion

In conclusion, our findings affirm that laparoscopic surgery is a safe and minimally invasive alternative to open surgery for patients with MCRC. Notably, laparoscopic surgery is associated with reduced estimated blood loss, improved recovery of bowel function, and shortened postoperative hospitalization. However, further extensive investigations are warranted to comprehensively elucidate the long-term implications and endorse the role of laparoscopic surgery in managing MCRC.

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Authors' contributions
Jiyun Li: conceptualization, formal analysis, methodology and writing original draft. Ruoxi Tian: investigation and resources. Hengchang Liu: investigation and resources. Haipeng Chen: project administration and supervision. Zhaoxu Zheng: funding acquisition, project administration and supervision.

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Data availability
The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board Committee of the Cancer Hospital, Chinese Academy of Medical Science, and Peking Union Medical College, Beijing, China. All patients enrolled in this study provided written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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