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Clinical comparative study of the modified superior mesenteric artery approach in total laparoscopic radical resection for right colon cancer - a single-center retrospective study

Lishuai Xu[1,2†], Jiawei Wang[3†], Yue Peng[1,2†], Chengwei Wu[1,2†], Song Wang[1,2], Xu Zhang[1,2], Changming Liang[1,2], Senlin Wan[1,2], Cheng Yang[1,2], Qingsheng Fu[1,2], Yabin Xia[1,2], Xiaoxu Huang[1,2*] and Li Xu[1,2*]

Abstract

Background To explore the safety and feasibility of the modified approach for accessing the superior mesenteric artery (SMA) in total laparoscopic radical resection for right colon cancer.

Methods This single-center retrospective study included 107 patients who underwent total laparoscopic radical resection of right colon cancer at The First Affiliated Hospital of Wannan Medical College between August 2022 and December 2023. 53 patients were in the modified SMA approach (modified group) and 54 patients were in the traditional SMA approach (control group). The control group and modified group underwent total laparoscopic radical resection of right colon cancer, and the following baseline and pathological characteristics of the two groups were compared: intraoperative condition, postoperative recovery, and postoperative complications. Our modified surgical method was to isolate the mesocolon using a cranial(the ligament of Treitz) -to- caudal(the pedicle of ileocolic) pathway and the orderly ligation of blood vessels in the SMA.

Results There was no statistically significant difference in the baseline characteristics or pathological data between the two groups. Compared with the traditional SMA approach, the modified SMA approach had a shorter surgical time($P<0.001$) and vascular dissection time ($P<0.001$) and less intraoperative blood loss ($P=0.000$). There was no statistically significant difference in the number of total harvested lymph nodes or positive harvested lymph nodes between the two groups of patients ($P>0.05$); There was no statistically significant difference in postoperative hospital stay, time to first flatus, time to pull out drainage tube and drainage between the two groups of patients ($P>0.05$), and there was no statistically significant difference in the incidence of complications between the two groups of patients ($P>0.05$).

†Lishuai Xu, Jiawei Wang, Yue Peng and Chengwei Wu contributed equally to this work.

*Correspondence:
Xiaoxu Huang
xiaoxuhuang1984@163.com
Li Xu
xulixuli1973@163.com

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

Conclusion The modified SMA approach in totally laparoscopic radical resection for right colon cancer can shorten the surgical and vascular dissection time, reduce intraoperative bleeding and reduce the surgical difficulty and intraoperative risk of the SMA approach for right colon cancer. In clinical practice, its safety and feasibility are relatively high, and it is worth promoting.

Trial registration The study was approved by the Ethics Committee of The First Affiliated Hospital of Wannan Medical College and registered with the China Clinical Trials Registry (ChiCTR2300075919, Date of Registration:2023-09-19-retrospective registration) http://www.chictr.org.cn/index.aspx.

Keywords Right colon cancer, Superior mesenteric artery, D3 lymphadenectomy

Introduction

Cancer is one of the leading causes of death in all countries of the world and is a major impediment to the extension of human life expectancy. According to statistics colorectal cancer is the third most common cancer and the second leading cause of death worldwide [1]. As a common type of colon cancer, the right colon cancer has the highest incidence, accounting for approximately 40% of all cases [2].

Since complete mesentery excision (CME) was introduced by Hohenberger et al. in 2009, it has become the accepted standard of care for the surgical treatment of right colon cancer. Compared with conventional surgery, CME focuses on complete resection of the mesentery of the colon, which has significantly improved surgical outcomes and a better oncologic prognoses [3, 4].

On the basis of CME, many scholars have also proposed different surgical approaches, such as the lateral to medial approach, cranial to caudal approach, medial to lateral approach, and combined approach. The lateral to medial approach opens the lateral peritoneum from the ileocecal region, allowing more precise access to Toldt's space. Expansion along Toldt's space reduces hemorrhage; effectively protects the head of the pancreas, duodenum, and other neighboring organs; and allows for clear visualization of the superior mesenteric vein (SMV) and its branches. The cranial to caudal approach is consistent with human embryonic development, and the fusion gap is dissected first, facilitating the identification of the Henle's trunk. The medial to lateral approach approach, in which the central vessels are treated first, is in accordance with the "no touch" principle, but the ligation of the central vessels at the beginning is more demanding for the operator, especially in patients with a high BMI, and the operation is difficult. The combined approach merges the advantages of the appellate approach, which perfectly balances tumor cure, surgical safety and convenience [5].

Meanwhile, laparoscopic D3 lymphadenectomy for right colon cancer proposed by Japanese scholars has become a mainstream procedure for the treatment of right colon cancer. D3 lymphadenectomy focuses on the ligation of blood vessels at the root of the colon as well as the thorough clearance of lymph nodes in the central area, and it has better surgical results for advanced tumors [6, 7].

Both surgical methods require that the lymph nodes at the root of the vessels be cleared as much as possible, thereby improving the surgical outcome. However, the anatomical variability of the right hemicolon vasculature is greater [8, 9], so safely recognizing and dissecting blood vessels can be a challenge for surgeons. In clinical practice, most scholars use the superior mesenteric vein as the internal measurement boundary for lymph node dissection. However, the right colon lymph generally drains to the superior mesenteric artery (SMA) and covers the lateral abdominal aspect of the SMA between the middle colic artery (MCA) and the ileocolic artery (ICA). Additionally, from the perspective of embryonic development, the lymphatic fatty tissue on the surface of the SMA belongs to the colonic mesentery, and consequently, the inner boundary of the CME may be the SMA [10–12]. Therefore, the SMA approach may be more consistent with the principles of CME and D3 lymphadenectomy.

A new SMA approach has been proposed by Luo, which can reduce the difficulty of early localization of the SMA and the risk of vascular injury during central vessel ligation [13], and although this new approach has some theoretical advantages over the traditional SMA approach, its superiority has not yet been demonstrated in randomized clinical trials (RCTs). In the present study, this new SMA approach was modified by applying the level advancement method in the treatment of vessels. This retrospective study compared the safety and feasibility of the modified SMA approach totally laparoscopic radical resection for right colon cancer, with the intention of providing a reference for the selection of surgical access modalities for future clinical treatment.

Materials and methods

Study design

This was a retrospective study of 119 patients who underwent totally laparoscopic radical resection for right colon cancer in the First Affiliated Hospital of Wannan Medical College from August 2022 to December 2023. After excluding 12 patients, 53 patients in the modified

group and 54 patients in the control group were included (Fig. 1). Laparoscopic radical surgery for right colon cancer was performed using the traditional SMA approach (control group) and modified SMA approach (modified group). Three-dimensional reconstruction of abdominal CT was performed in both groups to complete the preoperative examination, and patients with T2 stage or above and suspected lymph node metastasis underwent laparoscopic radical resection for right colon cancer with arterial access. Written consent was obtained before the surgery and we explained the advantages and disadvantages of these two techniques to the patient before the operation, and let the patient choose the technique they want to perform. Institutional review board approval was obtained prior to initiating the study. For the control group, the technical methods we adopted complied with Diao [10] et al.'s study, but the inner boundary of lymph node dissection is on the left side of the SMA. All patients were included in the 6-month postoperative follow-up. This study was performed in accordance with the principles stated in the Declaration of Helsinki. The study was approved by the Ethics Committee of The First Affiliated Hospital of Wannan Medical College and registered by the China Clinical Trials Registry (ChiCTR2300075919).

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) aged 18–75 years; (2) colonoscopy and pathology confirmed right colon cancer, and the tumor was evaluated to be resectable; (3) patients' preoperative imaging and colonoscopic pathology revealed a clinical stage of T2 + N + M0 [6]; (4) they did not receive any other treatments prior to surgery; and(5) the ASA was grade I-III. The exclusion criteria were as follows: (1) had two or more cancers or cancers causing obstruction, perforation, etc. requiring emergency surgery; (2) required combined resection of adjacent organs; (3) had severe hypertension, diabetes mellitus or other underlying diseases that made it difficult for them to tolerate surgery [14, 15]; (4) had multiple abdominal surgeries that resulted in extensive adhesions in the abdominal cavity; (5) refused to provide informed consent; and (6) any cases preformed by surgeons who were inexperienced in performing the modified SMA approach at the beginning.

Statistical analysis

The data were analyzed using SPSS26.0 software, and the quantitative information was expressed as the mean ± standard deviation after ensuring a normal distribution. An independent samples t-test was used for comparisons between two groups. The median (*P*25, *P*75) was used for data that were not normally distributed, and a non-parametric Mann-Whitney test was used for comparisons between two groups; qualitative information was expressed as a percentage (%), and a chi-square test was used for comparisons between two groups. A p value < 0.050 was considered significant.

Surgical methodology

Both groups underwent the same routine preoperative preparations for colon cancer, general anesthesia by trans-tracheal intubation was used, and surgery was performed by the same group of surgeons in both groups.

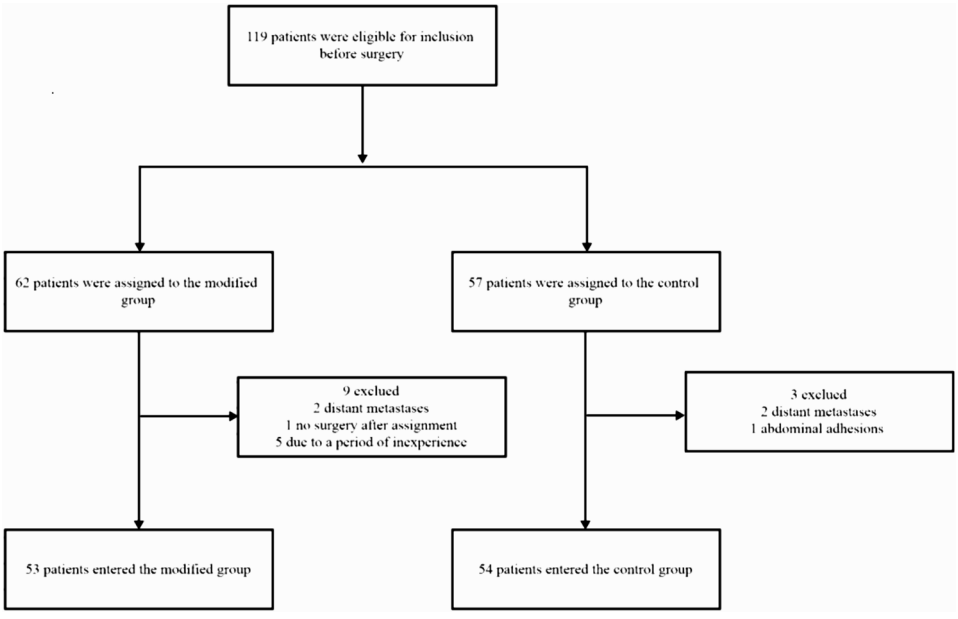

Fig. 1 Flow chart of the patient inclusion process

Modified group: The patient was supine with legs divided, head low and feet high with the right side elevated by 10°-15°, and a 5-hole Trocar puncture was used to explore the abdominal cavity to exclude peritoneal and distant metastases and to confirm the location of the tumor (Fig. 2). The ligament of Treitz is exposed and the pedicle of ileocolic vessels is pulled, with the ligament of Treitz as the cranial marker and the pedicle of ileocolic vessels as the caudal marker. The peritoneum on the right side of the ligament of Treitz was divided superiorly along the left side of the SMA in a cranial to caudal direction until just below the pedicle of ileocolic vessels (Fig. 3), and the lymphatic adipose tissue outside the SMA sheath was cleared without opening the SMA sheath. The mesentery of the mesenteric vascular surface was dissected along the surface of the SMA from the cranial to the caudal side in a flip-flop to the right, and the right colic artery (RCA), MCA, and middle colic vein (MCV) were ligated in a sequential root ligation (Fig. 4). After exposed the mesenteric artery to the lower edge of the pancreas and then freeing cephalad into the level of the omental sac, the Henle's trunk was revealed along the superior mesenteric vein, and the separation was continued up to the right gastric omental vein, ligate the tributaries of the Henle's trunk: the accessory right colic vein and the right colic vein, completing the cranial vascular ligation and lymph node dissection (Fig. 5). Continue to bare the SMV caudal. Expand the right Toldt's space to

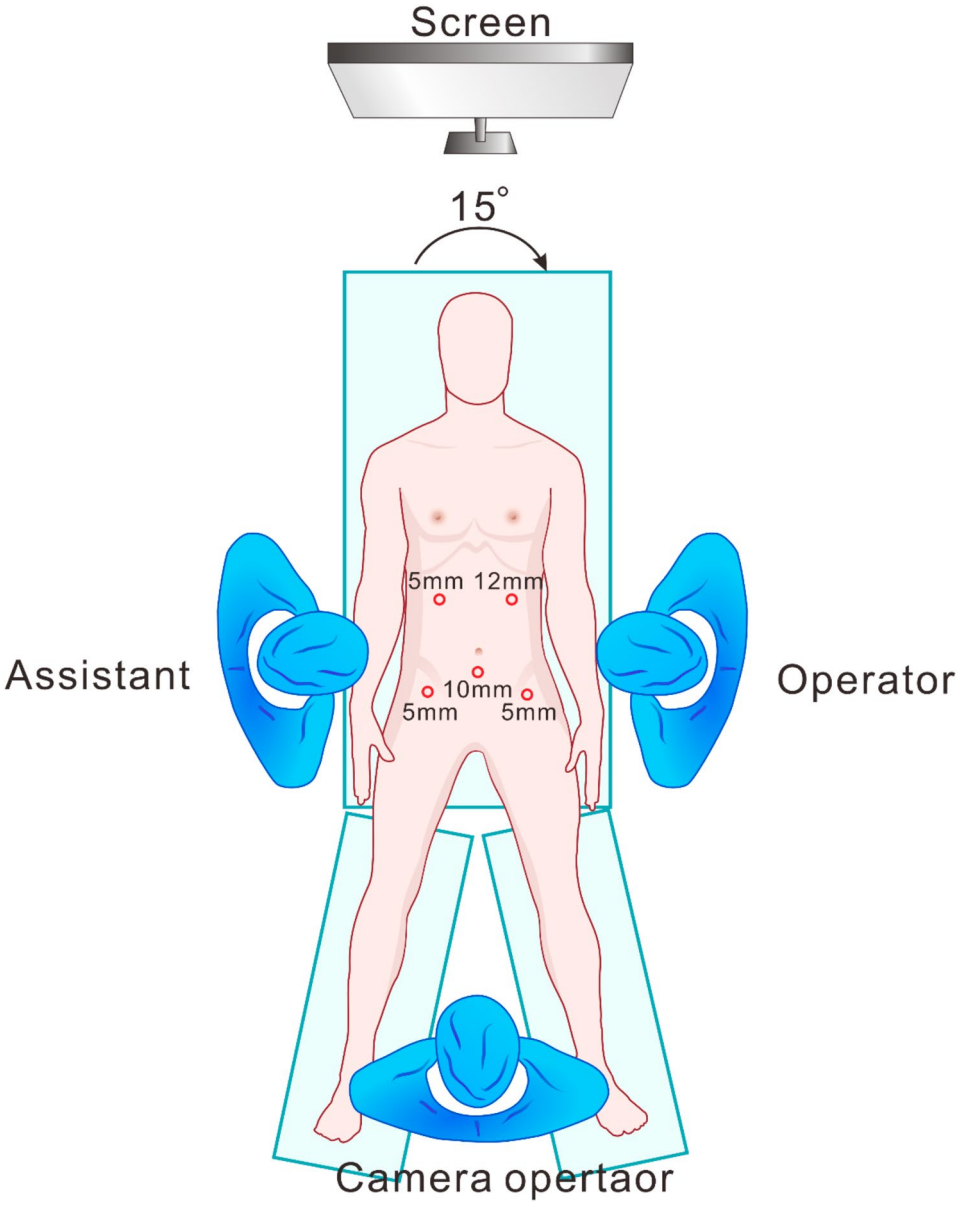

Fig. 2 Preoperative preparation: the position of patient, surgeon, screen, and trocar

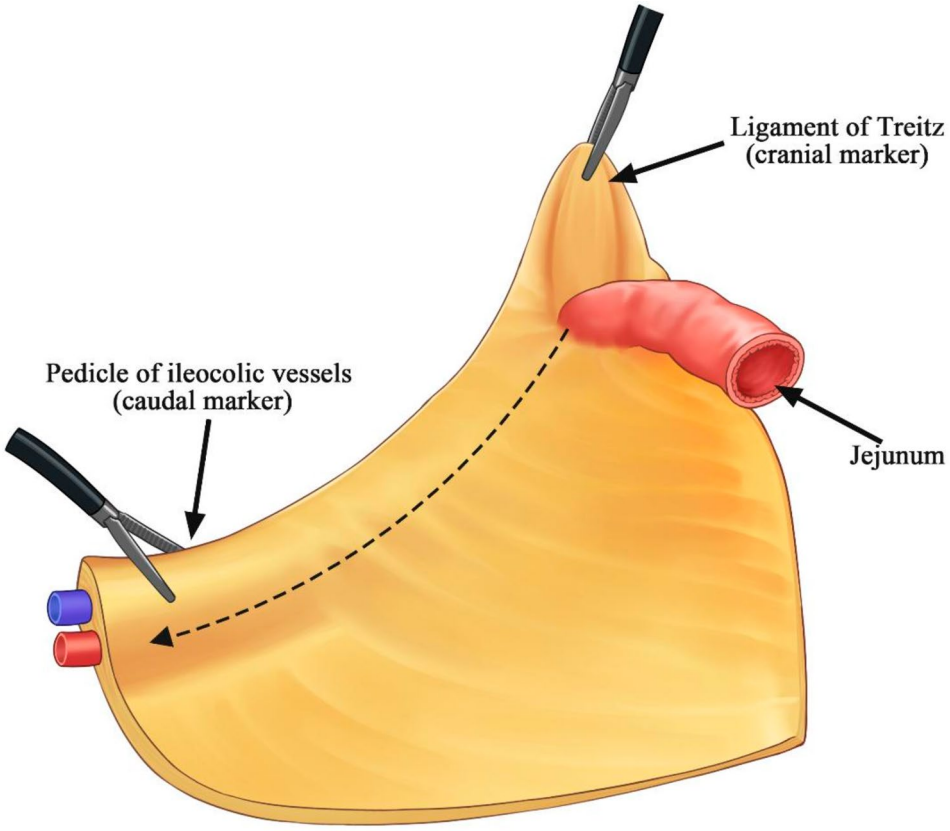

Fig. 3 The ligament of Treitz was used as the cranial marker, and the pedicle of ileocolic vessels was used as the caudal marker

expose the duodenum and pancreatic head and ligate the ICA and ileocolic vein (ICV) (Fig. 6). The gastrocolic and hepatocolic ligaments are separated and the transverse colon and hepatic flexure are moved. Finally, after ligating the ileocolic vessels and then converging from the caudal side approach, the closed transverse and ileal ends were cut off with a linear cutting closure, and the resected specimen was placed in a specimen bag without closing the mesenteric fissure. An abdominal incision of 3–5 cm was taken and the specimen was removed. Surgical specimens were sent for pathologic examination. Finally, the intestinal tube was arranged, and the drainage tube was left in the hepatorenal recess, and the abdominal cavity was closed after examination (Fig. 7).

Control group: The position was the same as that of the modified group. Only use the pedicle of ileocolic vessels as the caudal marker (Fig. 8). The lymphatic and fatty tissues outside the SMA sheath were incised along the left side of the SMA from the caudal to the cranial, and ICA, ICV, MCA and RCA were sequentially differentiated, separated, and cut off by root ligations, respectively. The lymph nodes were swept away, and the vascular sheaths of the SMV were opened. The SMV were made bare and isolated from the Henle's trunk, and the omental sac was entered after that to completely free the right colon mesentery. The remaining steps are the same as the modified group.

Results

Patient characteristics

Between August 2022 and December 2023, we performed total laparoscopic radical resection for right colon cancer for 107 patients. The results were 53 patients in the modified group and 54 patients in the control group. The baseline characteristics of the two groups are compared in Table 1. There was no significant difference in the baseline characteristics between the two groups ($P > 0.05$). All patients were included in the 6-month postoperative follow-up, and there was no 30-day re-hospitalization and mortality.

Surgical and pathological characteristics

The surgical and pathological results of the two groups are shown in Table 2. Compared with those in the control group, the surgical time and vascular dissection time were shorter in the modified group [(148.09 ± 29.99) min vs. (168.02 ± 28.36) min, $t = 3.532$, $P < 0.001$] [(35.89 ± 3.32) min vs. (53.87 ± 3.79) min, $t = 2.608$, $P < 0.001$], and the difference was statistically significant. Intraoperative blood loss in the modified group was (45.66 ± 7.68) ml vs.

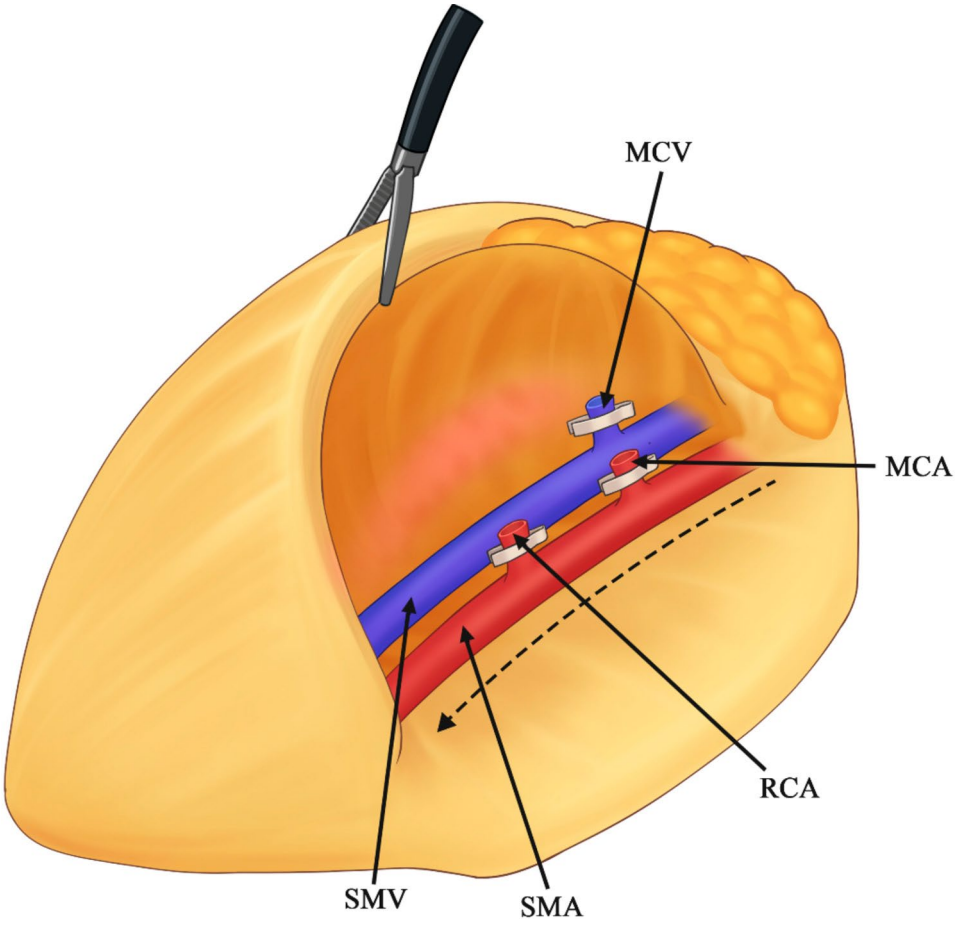

Fig. 4 Ligation of blood vessels in the SMA and SMV from cranial to caudal in sequence

(62.54 ± 9.67) ml in the control group, and the difference was statistically significant ($P = 0.000$). The two groups in terms of intraoperative transfusion, tumor size, tumor differentiation, T stage, N stage, total harvested lymph nodes, positive harvested lymph nodes, superior mesenteric artery typing (superior mesenteric arteries were divided into four types [16]), and specimen quality (specimen quality was divided into IA SMA complete exposure and IB SMA partial exposure [17]), Comparisons in terms of lymphatic vascular invasion and nerve invasion showed no statistically significant differences.

Postoperative recovery and complications

The postoperative recovery of the patients in both groups is shown in Table 3. The postoperative hospital stay, time to first flatus, time to pull out drainage tube and drainage were similar in both groups, and the differences were not statistically significant. There were no deaths during surgery in both groups, and 4 postoperative complications (7.5%) occurred in the modified group while 6 postoperative complications (11.1%) occurred in the control group (Table 4). One patient in the modified group was older, had poor general condition combined with diabetes mellitus and developed anastomotic leakage (Grade III, according to the Clavien-Dindo system [18]). There were 2 cases of chylous leakage and 1 case of incision infection (Grade I to II). In the control group, 6 cases of minor complications occurred (Grade I to II), including 1 case of lung infection, 2 cases of postoperative ileus, 2 cases of chylous leakage, and 1 case of gastric paralysis.

Discussion

Both CME and D3 lymphadenectomy are standard procedures for laparoscopic radical resection for right colon cancer. Since the concept of CME was introduced by Hohenberger et al. in 2009, surgery for right colon cancer has become more standardized. CME is based on theories of embryology and anatomy, with sharp separation along the primitive level of embryonic development and fine dissection to ensure the integrity of the colonic mesentery of the tumor and prevent tumor dissemination through the broken mesentery, whereas CME also emphasizes maximal clearance of lymph nodes and high ligation of blood-supplying vessels [19]. The CME has a better tumor prognosis compared to conventional surgery.

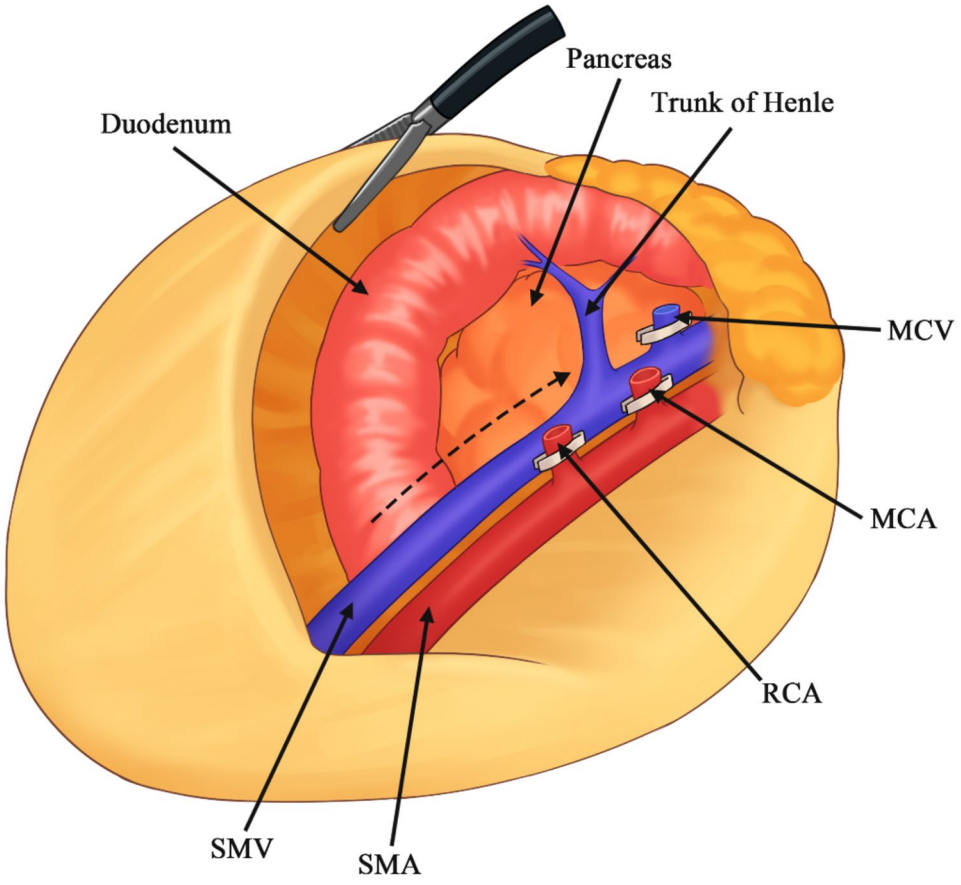

Fig. 5 The MCA and RCA are ligated, and the Toldts space is widened, revealing the duodenum and pancreatic head

D3 lymphadenectomy was proposed by Japanese scholars and has now become the standard procedure for surgical treatment of right colon cancer in Japan. According to the definition of the Japanese Society for Colorectal Cancer Research, D3 lymph node dissection is the dissection of the main lymph nodes (N3), intermediate lymph nodes (N2), and periintestinal lymph nodes (N1) consisting of lymph nodes from the roots of the ICA, RCA, and the MCA, and can be performed if preoperative examinations show that the patient's tumor is staged at stage T2 or above or has lymph node metastases [6]. D3 lymphadenectomy focuses on the ligation of blood vessels at the root of the colon as well as the complete clearance of lymph nodes in the central area, and it provides better surgical results for advanced tumors.

There are many surgical accesses for laparoscopic radical resection for right colon cancer, but there is no uniform standard at present. However, the surgical principles of laparoscopic radical resection for right colon cancer are determined, which mainly include two aspects: firstly, sharply separating the gap between the visceral fascia and the wall fascia, and completely resecting the colon and its mesentery; and secondly, ligating the blood-supplying arteries at a high level and sweeping lymph nodes at the root of the blood vessels. Although the criteria for both CME and D3 lymphadenectomy require high ligation of vessels and maximal lymph node clearance, there is disagreement about the medial boundary of lymph node clearance. Some scholars use the left side of the SMV as the inner boundary of dissection, while others use the SMA as the inner boundary of dissection. Those who use the left side of the SMV as the inner boundary of dissection believe that dissecting the arterial branches emanating from the SMA on the left side of the SMV is a D3 lymphadenectomy. This procedure only requires exposure of the SMV, which reduces the surgical risk and difficulty of exposing the SMA [20]. However, it has been shown that the right colon lymph generally drains to the SMA and covers the lateral abdominal aspect of the SMA between the MCA and the ICA. Also from the perspective of embryonic development, the lymphatic fatty tissue on the surface of SMA belongs to the colonic mesentery. So the inner boundary of the CME may be the SMA [11, 12], This is consistent with the requirements of D3 lymphadenectomy. Diao et al. have shown that there is no significant advantage in terms of operative time, intraoperative bleeding and postoperative complications between the left side of the

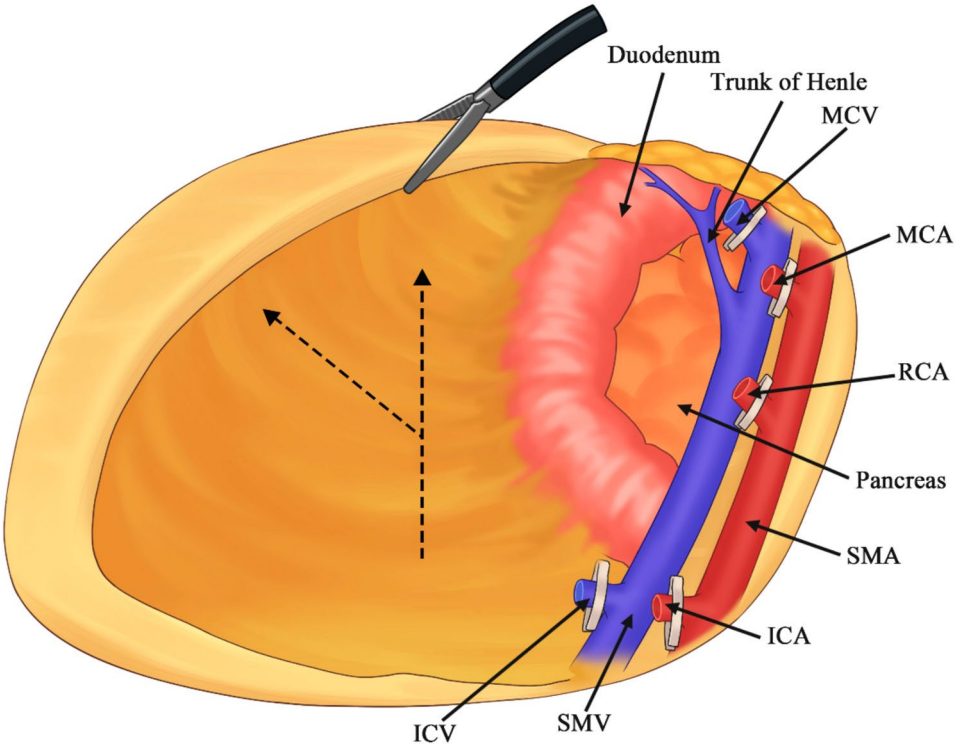

Fig. 6 Ligating the ICA and ICV to expand the right clearance

SMV and the midline of the SMA. On the contrary, the SMA can remove more positive lymph nodes and total lymph nodes [10]. Expanding the inner boundary of the right colon lymph node dissection to the left side of SMA can increase the number of detected lymph nodes and clear potential metastatic lymph nodes. The increase in the detection of total lymph nodes, even negative lymph nodes, has a positive significance for the prognosis of patients and is more in line with the principle of tumor radical treatment [21, 22].

The traditional SMA approach is to dissect the SMA from caudal to cephalad using the pedicle of ileocolic vessels as a single marker. However, this single marker to localize the SMA is inaccurate and may lead to difficulty in detecting the SMA, especially in obese patients, which increases the difficulty and time of the surgery. Meanwhile, the right colon has more vascular variants, so it is more difficult to accurately identify and nude the vessels, which may increase the risk of intraoperative bleeding due to unclear anatomical levels. A new SMA approach has been proposed, in which the ligament of Treitz and the pedicle of ileocolic vessels are used as markers to localize the cranial and caudal sides of the SMA, respectively. Compared with the traditional SMA approach, this new approach is more accurate in the localization of the SMA, reduces the risk of injury during vascular dissection, and reduces the difficulty of the surgery. The author improved this new SMA approach through the level advancement method when dealing with the blood vessels, and orderly dissection of the blood vessels, with a clearer hierarchy, which facilitates the expansion of the mesenteric space in the back to avoid taking a backward path.

In our study, we fully considered the influence of various factors on the operation, and CT three-dimensional reconstruction was performed on all patients preoperatively to understand the alignment of the superior mesenteric vessels, which is conducive to the safe conduct of the operation and reduces the influence of vascular variations on the surgical process. After excluding the cases who were inexperienced in performing the modified SMA approach at the beginning, the following results were obtained in this study. Compared with the control group, the surgical time and vascular dissection time were shorter in the modified group [148.09 ± 29.99) min vs. (168.02 ± 28.36) min, $t = 3.532$, $P < 0.001$], [(35.89 ± 3.32) min vs. (53.87 ± 3.79) min, $t = 2.608$, $P < 0.001$], indicating that the modified SMA approach could save the surgical time and vascular dissection time. This may be due to the accurate localization of the cranial and caudal sides of the SMA by the modified SMA approach, which reduces the time to locate and dissect the SMA at the beginning of the surgery. The reduction in surgical time can reduce the occurrence of intraoperative anesthesia accidents and surgical risk [23], as well as reduce the time of trauma and exposure, which is conducive to the patient's

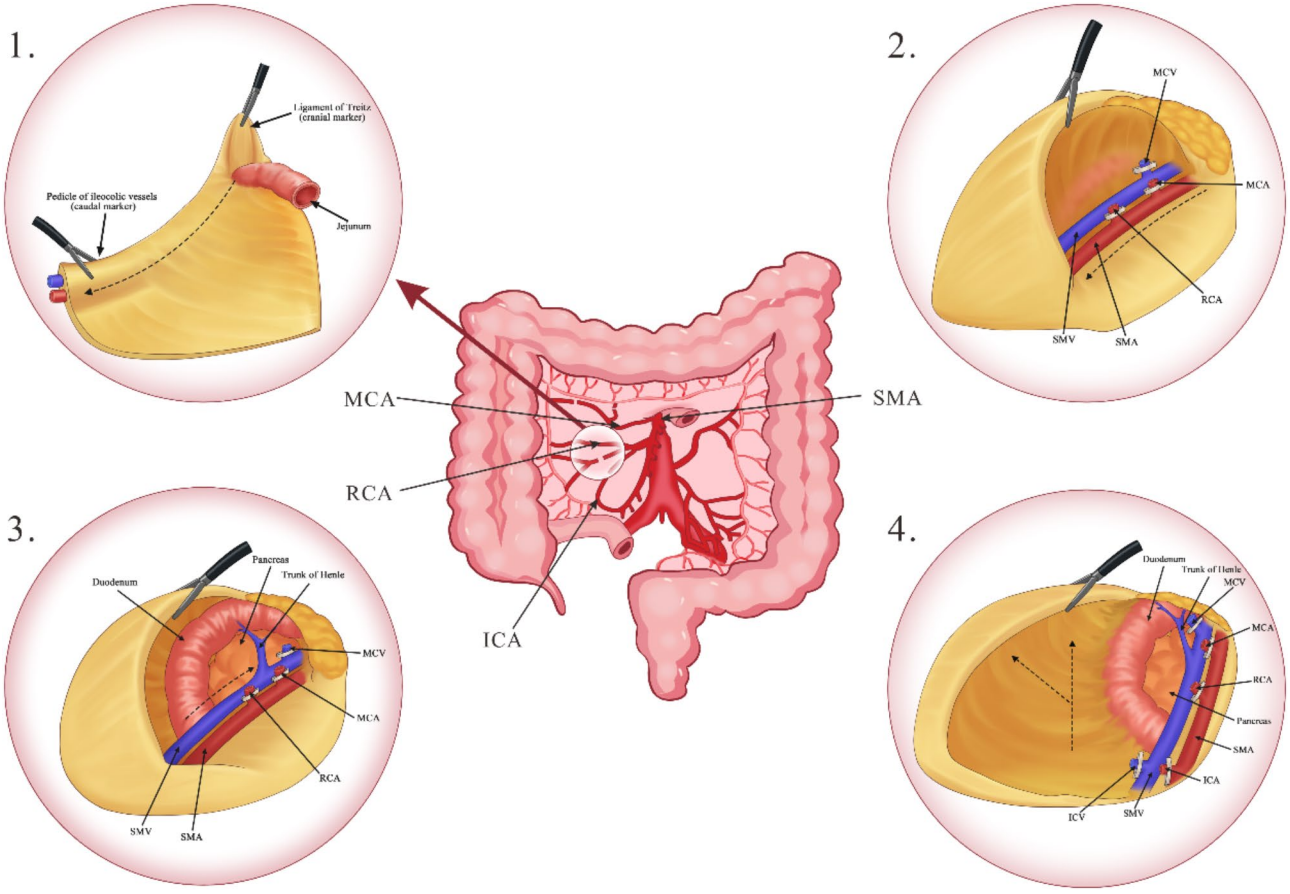

Fig. 7 The surgical steps of modified group

postoperative recovery. In terms of intraoperative blood loss, compared with the control group, the modified group had less intraoperative blood loss [(45.66 ± 7.68) ml vs. (62.54 ± 9.67) ml, $t = 9.984$, $P = 0.000$], indicating that accurate intraoperative localization of the SMA can reduce the risk of intraoperative blood loss due to unclear vessel localization. The reduction of intraoperative blood loss can better expose the surgical field and reduce the damage caused by unclear surgical field. The results of this study also showed that the total harvested lymph nodes, positive harvested lymph nodes, postoperative hospital stay, time to first flatus, time to pull out drainage tube, drainage, and postoperative complication rate were compared between the two groups, and the differences were not statistically significant ($P > 0.05$). This suggests that the modified SMA approach does not affect the effect of lymph node dissection and the procedure is safe.

Compared with the research results of Luo [13], their median surgical time is 180 min and the median intraoperative blood loss is 50 ml. We obtained shorter surgical time and less intraoperative blood loss, which may be due to their small sample size of only 21 patients included. They are the first to use this new SMA approach, which may have an impact on the surgical results. Looking forward to the publication of their subsequent research results. Yi's [10] research shows that the surgical time of the CC + SMA group is 170.04 ± 43.10 min, and the intraoperative blood loss is 91.07 ± 55.12 ml. Compared with them, our modified group has a shorter surgical time and less intraoperative blood loss.

Regarding complications, during the two groups of surgeries performed, fluid leakage was sometimes found when the SMA was dissected, which may have been caused by damage to the lymphatic network during lymph node clearance [24], leading to the development of chylous leakage. Thorough intraoperative coagulation of suspected lymphatics, as well as postoperative conservative treatment, can prevent and treat this complication. One case of gastric paralysis occurred in the control group, probably due to damage to the autonomic function within the arterial sheath during the clearance of the SMA.Both groups of patients were cured by conservative treatment and discharged from the hospital without any obvious complaints of discomfort.

The surgical difficulty of radical right hemicolectomy for right hemicolonic cancer with modified SMA approach is high at the beginning and requires an

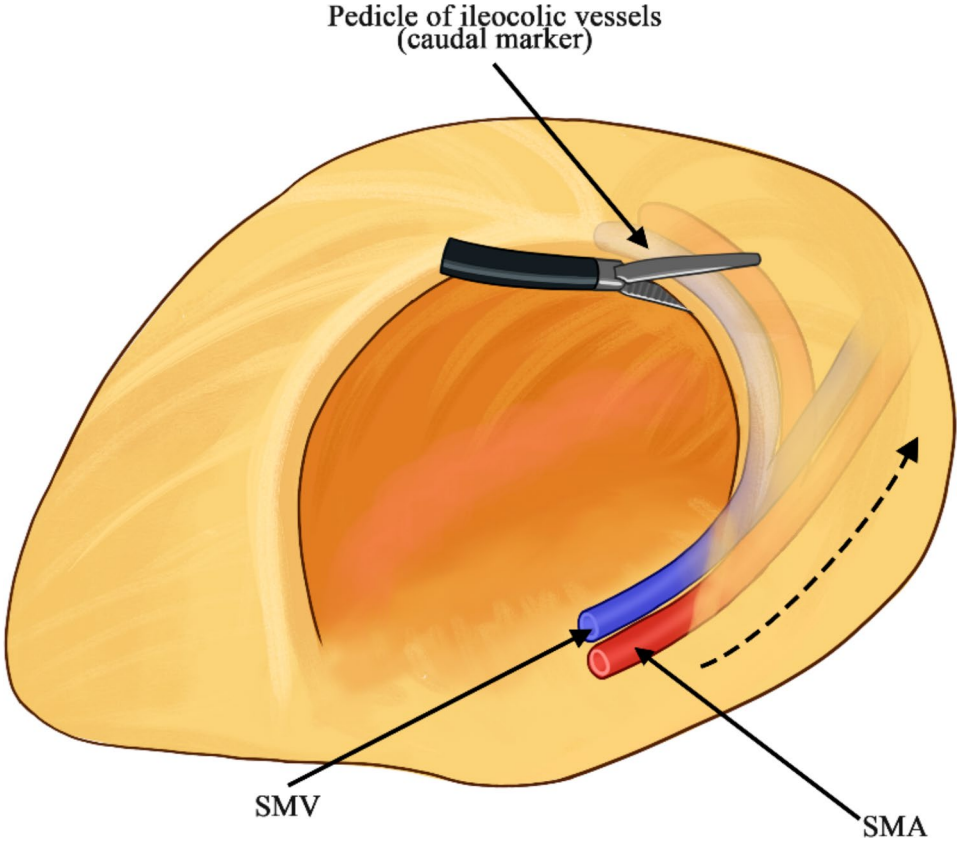

Fig. 8 The pedicle of ileocolic vessels was used as the caudal marker

Table 1 Patients' preoperative characteristics

Variables		Modified group ($n=53$)	Control group ($n=54$)	t	*p*
Sex	Male	28(52.8%)	30(55.6%)	0.080	0.777
	Female	25(47.2%)	24(44.4%)		
Age(year)		62.09 ± 11.23	64.59 ± 9.26	1.257	0.212
BMI(kg/m^2)		21.25 ± 2.93	21.75 ± 3.18	0.844	0.400
ASA	I	7(13.2%)	8(14.8%)	-0.157	0.875
	II	27(50.9%)	25(46.3%)		
	III	19(35.8%)	21(38.9%)		
Tumor locations	Ileocecal section	18(34.0%)	17(31.5%)	0.096	0.953
	Ascending colon	25(47.2%)	27(50.0%)		
	Hepatic flexure	10(18.9%)	10(18.5%)		
Preoperative Hb level (g/L)		107.36 ± 20.32	105.07 ± 16.39	-0.641	0.523
Preoperative Alb level (g/L)		41.68 ± 5.66	40.13 ± 5.21	-1.473	0.144
Comorbidity	Yes	18(34.0%)	24(44.4%)	1.233	0.267
	No	35(66.0%)	30(55.6%)		

Table 2 Surgical and pathological characteristics

Variables		Modified group($n=53$)	Control group($n=54$)	t	*p*
Surgical time(min)		148.09 ± 29.99	168.02 ± 28.36	3.532	< 0.001
Vascular dissection time(min)		35.89 ± 3.32	53.87 ± 3.79	2.608	< 0.001
Intraoperative blood loss (ml)		45.66 ± 7.68	62.54 ± 9.67	9.984	0.000
Transfusion	Yes	1(1.9%)	2(3.7%)	0.000	1.000
	No	52(98.1%)	52(96.3%)		
Tumor size (cm)		3.96 ± 1.04	3.87 ± 0.80	-0.470	0.639
Tumor differentiation	Poorly differentiated	17(32.1%)	15(27.8%)	0.346	0.872
	Moderately differentiated	32(60.4%)	34(63.0%)		
	Mucous adenocarcinoma	4(7.5%)	5(9.3%)		
T stage	2	10(18.9%)	6(11.1%)	-0.795	0.426
	3	33(62.3%)	37(68.5%)		
	4	10(18.9%)	11(20.4%)		
N stage	1	29(54.7%)	31(57.4%)	-0.349	0.727
	2	21(39.6%)	21(38.9%)		
	3	3(5.7%)	2(3.7%)		
Total harvested lymph nodes		23.60 ± 1.77	23.17 ± 2.48	-1.048	0.297
Positive harvested lymph nodes		3.00(2.00,3.50)	2.50(2.00,3.00)	-0.878	0.380
Superior mesenteric artery typing	1	39(73.6%)	43(79.6%)	1.783	0.423
	2	14(26.4%)	10(18.5%)		
	3	0(0.0%)	1(1.9%)		
	4	0(0.0%)	0(0.0%)		
Specimen quality	IA	22(41.5%)	18(33.3%)	0.764	0.382
	IB	31(58.5%)	36(66.7%)		
Lymphatic vascular invasion	Yes	20(37.7%)	24(44.4%)	0.497	0.481
	No	33(62.3%)	30(55.6%)		
Nerve invasion	Yes	8(15.1%)	10(18.5%)	0.224	0.636
	No	45(84.9%)	44(81.5%)		

Table 3 Recovery after surgery

Variables		Modified group($n=53$)	Control group($n=54$)	t	*p*
Postoperative hospital stay (day)		7.25 ± 1.47	7.46 ± 2.04	0.632	0.529
Time to first flatus (day)		3.30 ± 0.95	3.52 ± 0.77	1.295	0.198
Time to pull out drainage tube (day)		5.17 ± 1.54	5.13 ± 1.58	-0.133	0.894
Drainage (ml)		390.00(227.00,560.00)	330.50(260.75,422.50)	-0.629	0.529
Postoperative complications	Yes	4(7.5%)	6(11.1%)	0.091	0.763
	No	49(92.5%)	48(88.9%)		
Classification of complications (Clavien–Dindo system)	I-II	3(75.0%)	6(100.0%)	Exact probabilistic method	0.400
	III-IV	1(25.0%)	0(0.0%)		

Table 4 Perioperative complications

Complications	Modified group($n=53$)	Control group($n=54$)
Lung infection	0	1
Chylous leakage	2	2
Postoperative ileus	0	2
Anastomotic leakage	1	0
Incision infection	1	0
Gastric paralysis	0	1

experienced surgeon as well as a certain amount of surgical volume to learn to master.

However, this study has several limitations.1) Its single-center and retrospective study. 2) the mean BMI is low as most of the patients with colon cancer are lean. 3) The sample size of this study is small and the results of clinical data from a single center, which needs to be evaluated by a large sample as well as by a larger number of surgeons. 4) Explaining two surgical methods for patients to choose for themselves may lead to bias. 5) This study focuses on the safety and feasibility of the surgical approach, and the long-term oncological prognosis is still under follow-up.

Conclusion

The modified superior mesenteric artery approach in totally laparoscopic radical resection for right colon cancer can short surgical time, vascular dissection time and reduce intraoperative blood loss, which contributes to patient benefit, and its safety and feasibility are higher in clinical practice, which is worthy of clinical promotion.

Supplementary Information

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Supplementary Material 1

Author contributions

LSX, JWW, CWW and YP: Conceptualization, Figure preparation, & Writing - Original draft preparation. LX, XXH and YBX: Conceptualization, Supervision, Writing - Reviewing & editing. SW, XZ, CML, CY, QSF and SLW: Writing - Reviewing & editing. All authors read and approved the final manuscript.

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Data availability

Data available on request from the authors.

Declarations

Ethical approval

The study was performed in accordance with the Declaration of Helsinki. The study was approved by the Ethics Committee of The First Affiliated Hospital of Wannan Medical College and registered by the China Clinical Trials Registry (ChiCTR2300075919). Informed consent was obtained from all subjects and/or their legal guardian(s). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Disclosures

Lishuai Xu, Jiawei Wang, Yue Peng, Chengwei Wu, Song Wang, Xu Zhang, Changming Liang, Senlin Wan, Cheng Yang, Qingsheng Fu, Yabin Xia, Xiaoxu Huang and Li Xu have no conflicts of interest or financial ties to disclose.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Gastrointestinal Surgery, The First Affiliated Hospital of Wannan Medical College, No.2, Zheshan West Road, Wuhu, Anhui, Anhui 241001, China
[2]Anhui Province Key Laboratory of Non-Coding RNA Basic and Clinical Transformation, Wuhu, Anhui, China
[3]Department of General Surgery, Maanshan Maternal and Child Health Care Hospital, No.446 Jiashan Road, Ma'anshan, Anhui 243000, China

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