

Completely medial versus hybrid medial approach for laparoscopic complete mesocolic excision in right hemicolon cancer

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Abstract

Objective To explore the feasibilities between operational approaches for laparoscopic complete mesocolic excision (CME) to right hemicolon cancer.

Methods This prospective randomized controlled trial included patients admitted to a Shanghai minimally invasive surgical center to receive laparoscopic CME from September 2011 to January 2013 randomized into two groups: hybrid medial approach (HMA) and completely medial approach (CMA). The feasibilities and strategies of the two techniques were studied and compared. Furthermore, the operation time and vessel-related complications

were designed to be the primary end points, and other operational findings, including the classification of the surgical plane and postoperative recovery, were designed to be the secondary end points for this study.

Results After screening, 50 cases were allocated to the HMA group and 49 to the CMA group. Within the HMA group, there were 48 cases graded with mesocolic plane and 2 with intramesocolic plane. For the CMA group, there were 42 cases graded with mesocolic plane and seven with intramesocolic plane. The differences between the two were insignificant, as were the number of lymph nodes retrieved. The mean±standard deviation total operation time for the CMA group was 128.3 ± 36.4 min, which was significantly shorter than that for the HMA group, 142.6 ± 34.8 min. For the CMA group, the time involved in central vessel ligations and laparoscopic procedures was 58.5 %, 14.1 and 81.2 ± 23.5 min, respectively, which

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were shorter than the HMA group. The vessel-related complication rate was significantly higher in the HMA group.

Conclusions Laparoscopic CME via the total medial approach is technically feasible after the precise identification of the surgical planes and spaces for the right hemicolon. The procedure has a shorter operation time and fewer vessel-related complications.

Keywords Complete mesocolic excision · Laparoscopic right hemicolectomy · Medial access · Randomized controlled trial

Research has demonstrated that complete mesocolic excision (CME) has the potential to become the standard procedure for colon cancer surgery as a result of its effectiveness in reducing local recurrence rate and improving prognosis [1, 2]. Two modes of access characterize this procedure: lateral and medial [3–5]. Most traditional laparoscopic procedures use lateral access [1]. Previous research has demonstrated that technically, laparoscopic CME via medial access is comparable to a laparoscopic procedure [6, 7]. Accordingly, intermesenteric space (IMS) is located posterior to the greater omentum and superior to the transverse colon mesentery. It communicates with the transverse retrocolic space (TRCS) by passing behind the root of the transverse colon mesentery [8]. Therefore, dissection of the transverse colon mesentery requires the entrance of the IMS.

Our medical center proposed two approaches for medial access: a hybrid medial approach (HMA) and a completely medial approach (CMA). HMA involves the entrance to the IMS by an incision of the gastrocolonic ligament followed by the dissection of the middle colic vessels and the Henle trunk in a top-to-bottom fashion. The approach is capped by the dissection of the inferior edge of the pancreas, requiring the blending of both top-to-bottom and bottom-to-top approaches. CMA, on the other hand, involves a bottom-to-top approach in every step, including the entrance of IMS through TRCS; dissection of the middle colic vessels and the Henle trunk; and dissection of the inferior edge of the pancreas.

The main goal of this study was to investigate the technical feasibility and strategies of the two approaches.

Methods

Study design

This prospective randomized controlled trial included 102 of 113 consecutive patients admitted to a Shanghai minimally

invasive surgical center, Ruijin Hospital affiliated to Shanghai Jiaotong University School of Medicine, to receive laparoscopic CME for right hemicolon cancer from September 2011 to January 2013 who had signed informed consent to participate in the study, which was approved by the ethics committee of Ruijin Hospital. Patients were randomized into two groups, HMA and CMA. Eleven of 113 patients were excluded from the study because they did not agree to the terms of the consent form.

The inclusion criteria were as follows: patients (1) who had carcinoma of cecum, ascending colon, or hepatic flexure identified by preoperative histopathological findings; (2) whose preoperative tumor staging was I, II, or III according to the 6th edition of UICC tumor classification I; (3) whose tumor diameter was less than 7 cm; and (4) who received elective surgery. The exclusion criteria were as follows: patients (1) who had malignant lymphoma and benign tumor for right hemicolon; (2) whose preoperative tumor staging was stage IV; (3) whose tumor was exceedingly large (7 cm or larger), infiltrated tissues in vicinity, and/or invaded important vessels; and (4) who had emergent presentation. After the selected patients provided informed consent, each drew 1 of 2 opaque envelopes to be assigned to a random grouping. Patients who drew an envelope containing the letter H were assigned to the HMA group; those who drew the letter C were assigned to the CMA group. Fifty-two and 50 patients were assigned to the HMA and CMA groups, respectively.

Video and photographs of the operation and the resected samples were assessed by three independent professional observers to evaluate the quality of the approaches. Two patients in the HMA group and one patient in the CMA group were excluded as a result of the lack of clear video or photographs sufficient to evaluate the quality of the surgery. Operation time and vessel-related complications were designed to be the primary end points; other operational findings, including the classification of the surgical plane and postoperative recoveries, were designed to be secondary end points.

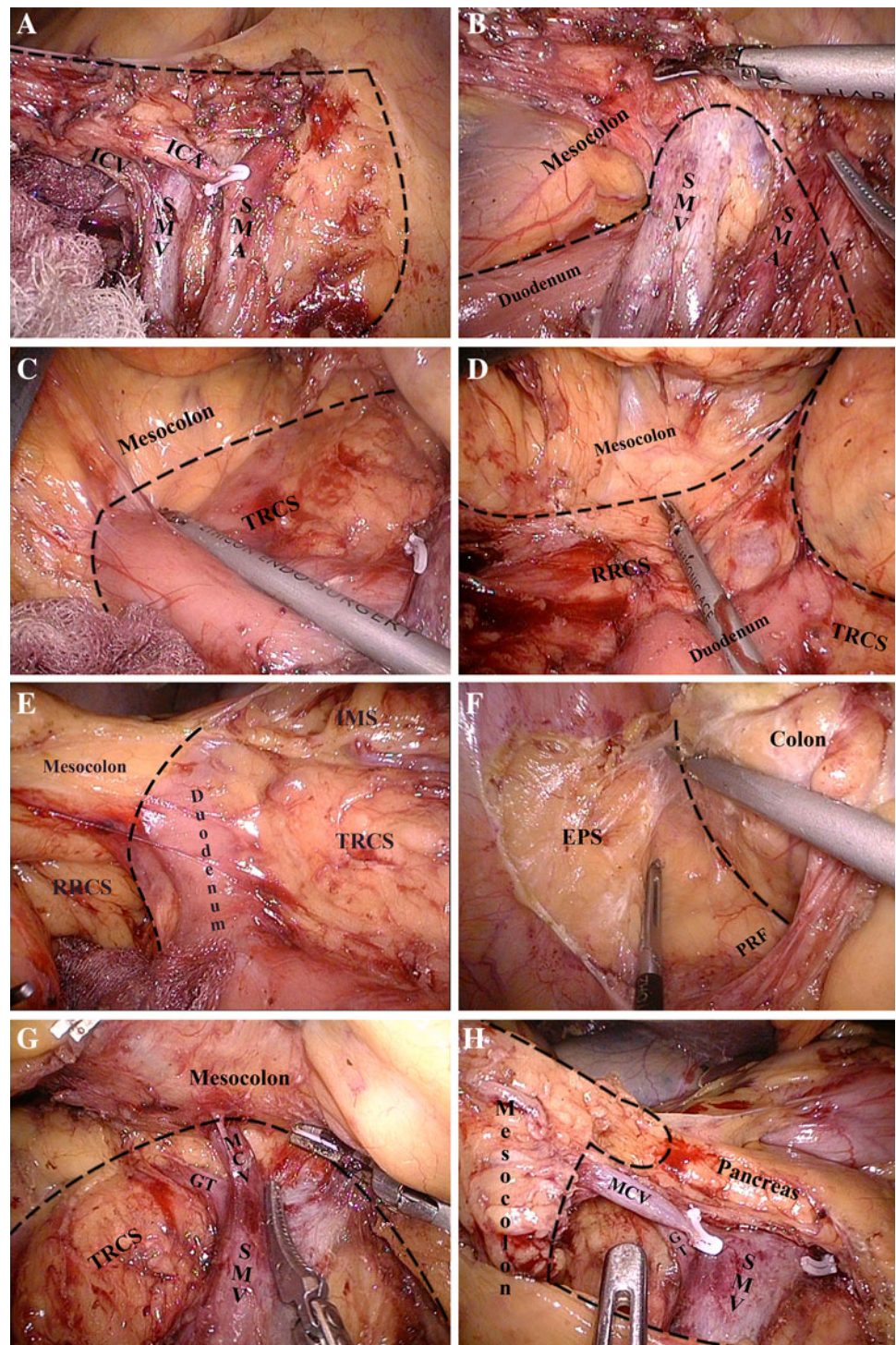
Operational approaches

Both HMA and CMA require mesocolon excision and central vessel ligation [1, 2].

HMA strategies

The IMS is entered via an incision of the gastrocolonic ligament, followed by the dissection of the middle colic vessels and the Henle trunk in a top-to-bottom fashion. The approach is capped by dissection at the inferior edge of the pancreas, requiring the blending of both top-to-bottom and bottom-to-top approaches.

Fig. 1 Complete mesocolon excision for CMA. **A** Initiation. **B** Dissection of surgical trunk. **C** TRCS exploration. **D** RRCS exploration. **E** Interspace between TRCS and IMS via transverse mesocolon. **F** extraperitoneal space (EPS) and prenal fascia. **G** Middle colic vessels and Henle trunk in bottom-to-top fashion. **H** Middle colic vessels and Henle trunk in top-to-bottom fashion

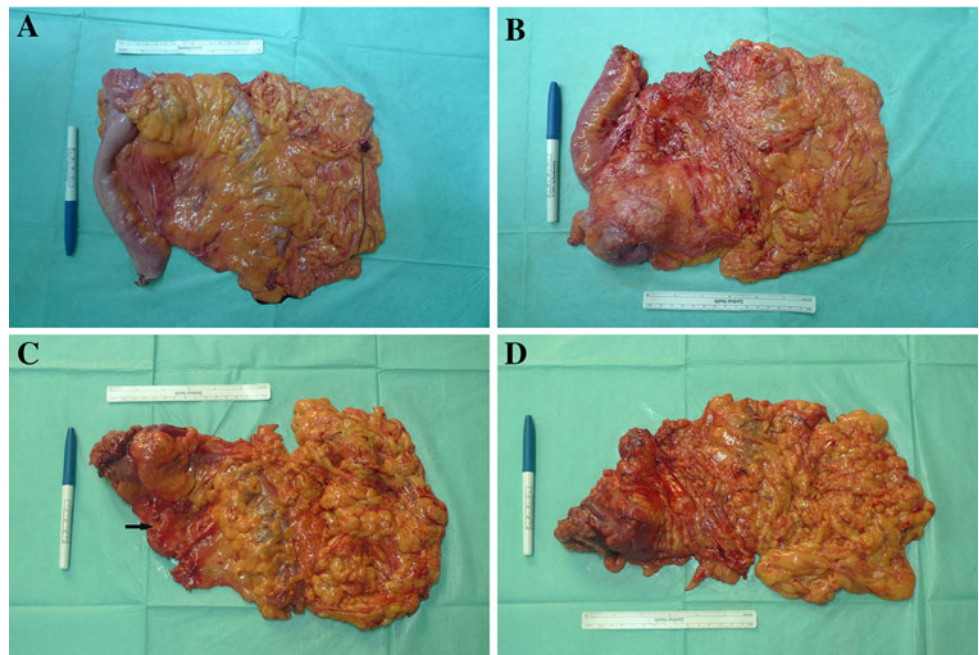


CMA strategies

The dissection starts at the ileocolic vessel and proceeds along the superior mesenteric vein (SMV) to enter the TRCS in bottom-to-top fashion. The dissection of the

TRCS is extended laterally to the right retrocolic space (RRCS) and superiorly enter the IMS, followed by the dissection of middle colon vessels, the Henle trunk, and pancreatic lower edge in a bottom-to-top fashion (Fig. 1).

Fig. 2 Photographs of the specimens. **A** *Front view* of the mesocolon plane. **B** *Reverse view* of the mesocolon plane. **C** *Front view* of the intramesocolic plane. **D** *Reverse view* of the intramesocolic plane



Comparisons

Operational assessments

We referred to the evaluation system of West et al. [9] to assess the quality of the operation, as follows: (1) muscularis propria plane (defined as a poor plane of surgery—little mesocolon excised with the incision extending down onto the muscularis propria); (2) intramesocolic plane (moderate plane of surgery—partial mesocolon excised with irregular shape but incisions do not reach down to the muscularis propria); and (3) mesocolon plane (good plane of surgery—intact mesocolon excised without defects and high ligation of the supply vessels) (Fig. 2).

Central vessel ligation time

The central vessel ligation time was part of the whole operation time, which represented the duration required for procedures starting from the dissection of the pedicle to ileocolic vessel via the ligations of ileocolic vessels, right colon vessels, Henle trunk, and middle colon vessels to the establishment of the connections between the IMS and the TRCS.

Laparoscopic procedure time

The laparoscopic procedure time was part of the total operation time, from insertion of the trocars to complete the vessel ligations and mobilization of the colon.

Statistical analysis

All calculations and analyses were performed by SPSS software, version 15.0 (SPSS, Chicago, IL). Quantitative data were expressed as mean \pm standard deviation. Student's *t* test was used to compare the differences between the two groups; $P < 0.05$ was considered statistically significant.

Results

General information

Forty-nine and 50 patients were assigned to the CMA and HMA groups, respectively (Table 1). The sex, tumor locations, tumor classifications, and body mass index of both groups were not significantly different.

Operational assessment

Forty-eight and 2 cases were evaluated for the mesocolic and intramesocolic planes, respectively, in the CMA group, whereas 42 and 7 cases were assessed for the mesocolic and intramesocolic planes, respectively, in the HMA group. The differences between the two groups were insignificant.

Evaluation in lymph node resections

The mean resection sample length in the CMA group was 22.3 ± 6.3 cm, which was not different from the HMA group, 23.1 ± 6.1 cm. The number of lymph nodes retrieved

Table 1 General information of patients between CMA and HMA

Characteristic	CMA (<i>n</i> = 49)	HMA (<i>n</i> = 50)	<i>P</i>
Sex			
Male	26	24	0.615
Female	23	26	
Tumor location			
Cecum	8	12	0.471
Ascending colon	18	20	
Hepatic flexure	23	18	
Tumor stage			
I	3	5	0.736
II	20	18	
III	26	27	
BMI (kg/m ²)	25.3 ± 3.2	26.1 ± 2.6	

CMA completely medial approach, HMA hybrid medial approach, BMI body mass index

Table 2 Comparison in lymph node resections

Characteristic	CMA (<i>n</i> = 49)	HMA (<i>n</i> = 50)	<i>P</i>
Sample length (cm)	22.3 ± 6.3	23.1 ± 6.1	0.642
No. of lymph node collected	20.3 ± 5.8	19.2 ± 6.7	0.564
No. of positive lymph nodes (stage III)	7	8	
Subpylorus (<i>n</i>) (hepatic flexure)	5	4	
Greater curvature mesentery (<i>n</i>)	3	4	

CMA completely medial approach, HMA hybrid medial approach

in the CMA group was 20.3 ± 5.8. In the stage III group, there were seven cases (26.9 %) of lymph nodes located at the root of the vessels. Among 23 patients with tumor located at the hepatic flexure who underwent subpyloric lymph nodes resection, lymph node metastasis was found in five (21.7 %), with three cases (6.1 %) of positive lymph nodes observed in the greater omentum along the greater curvature. In the HMA group, the mean number of lymph nodes collected was 19.2 ± 6.7. In the stage III group, there were eight cases (26.9 %) of lymph nodes located at the root of the vessels. Among 18 patients with tumor located at the hepatic flexure who underwent subpyloric lymph node resection, lymph node metastasis was found in four cases (22.2 %), with four cases (8.0 %) of positive lymph nodes observed in greater omentum along the greater curvature. The above data from both groups were statistically the same (Table 2).

Operational findings

Table 3 shows the operational findings between the CMA and HMA groups. The total operation time for the CMA group was 128.3 ± 36.4 min, which was significantly

Table 3 Operational findings between CMA and HMA

Characteristic	CMA (<i>n</i> = 49)	HMA (<i>n</i> = 50)	<i>P</i>
Total operation time (min)	128.3 ± 36.4	142.6 ± 34.8	<0.05
Central vessel ligation time (min)	58.5 ± 14.1	68.3 ± 15.2	<0.05
Laparoscopic procedure time (min)	81.2 ± 23.5	92.7 ± 25.6	<0.05
Intraoperative blood loss (mL)	75.8 ± 35.2	78.2 ± 28.7	0.325
Postoperative recovery			
Flatus recovery time (d)	2.5 ± 1.8	2.6 ± 1.5	0.651
Liquid intake time (d)	3.6 ± 2.1	3.8 ± 1.9	0.721
Hospitalization (d)	12.1 ± 4.5	12.7 ± 5.6	0.569

CMA completely medial approach, HMA hybrid medial approach

shorter than the HMA group, 142.6 ± 34.8 min. Also, the time required for the central vessel ligation and the laparoscopic procedure was 58.5 ± 14.1 and 81.2 ± 23.5 min, respectively, for CMA; these times were significantly shorter than HMA, 68.3 ± 15.2 and 78.2 ± 28.7 min, respectively. Blood loss, postoperative flatus recovery time, postoperative liquid intake time, and hospitalization were not significantly different between the two groups.

Operational complications

Postoperative that complications occurred in CMA group included 1 case of pneumonia, 1 case of hemorrhage, and 1 case of chylous leakage, all of which were effectively treated by relevant conservative treatments. The number of postoperative complications was statistically equal between the two groups. CMA had relatively fewer vessel-related complications, which implicated the superior mesenteric, ileocolic, right colic, middle colic, right gastroepiploic, and pancreaticoduodenal vessels and the Henle trunk; however, this did not reach statistical significance. HMA had relatively more hemorrhages caused by injuries of the pancreaticoduodenal vessels (Table 4).

Discussion

Anatomic strategies for CMA to CME

Traditional laparoscopic CME utilizes lateral access, which starts by mobilizing the right hemicolon in a lateral-to-medial fashion [1, 2]. Sharp dissection between the visceral fascia covering the pancreas plus mesentery and the parietal fascia covering the retroperitoneal tissues was applied until the vessels that supplied the colon near the superior mesenteric artery were revealed. On the other hand,

Table 4 Comparisons in vessel-related complications

	CMA (<i>n</i> = 49)	HMA (<i>n</i> = 50)	<i>P</i>
Vessel-related complication	12 (24.5 %)	19 (38 %)	0.147
Superior mesenteric vessel	0	1	
Ileocolic vessel	1	2	
Right colic vessel	1	1	
Middle colic vessel	4	6	
Henle trunk	0	1	
Right gastroepiploic vessel	3	2	
Pancreaticoduodenal vessel	3	6	

CMA completely medial approach, HMA hybrid medial approach

laparoscopic CME facilitates medial access, which completes dissection of the surgical trunk and central vessel ligation followed by mobilization of the colon in an inferior medial-to-superior lateral fashion [6]. The mobilization of the right hemicolon is based on three potential avascular surgical spaces bound by one surgical plane, the guts, and a nearby structure, the prerenal fascia, which provides a smooth surgical plane for the mobilization of the right hemicolon [8]. Furthermore, the RRCS, TRCS, and IMS, located between the transverse mesocolons, produce a surgical space, IMS, for the mobilization of right hemicolon. The IMS is situated posterior to greater omentum and superior to transverse mesocolon. It commutes with the TRCS posteriorly to the root of the transverse mesocolon. Therefore, the mobilization of transverse mesocolon requires the entrance of the IMS (Fig. 3).

According to the anatomical theories behind CMA, complete transverse mesocolon excision is achieved by the direct cranial extension of the TRCS to enter the IMS. With such a strategy, the mesocolon is dissected in a top-to-bottom fashion at once. In theory, this fashion complies

better to the principles of CME. In the meantime, it can avoid repetitive flipping of the colon and the mesocolon, which lead to confusion in recognizing anatomical structures, which further causes failure in complying with the requirements of CME. In addition, this strategy can dissect the inferior margin of the pancreas with associated branched vessels under direct vision, which results in less blood loss. The present study demonstrated that CME requires less time for both central vessel ligation and laparoscopic procedures. Meanwhile, it reduces vessel-related complications, especially the pancreaticoduodenal vessels. Overall, CMA is a preferred choice for laparoscopic CME.

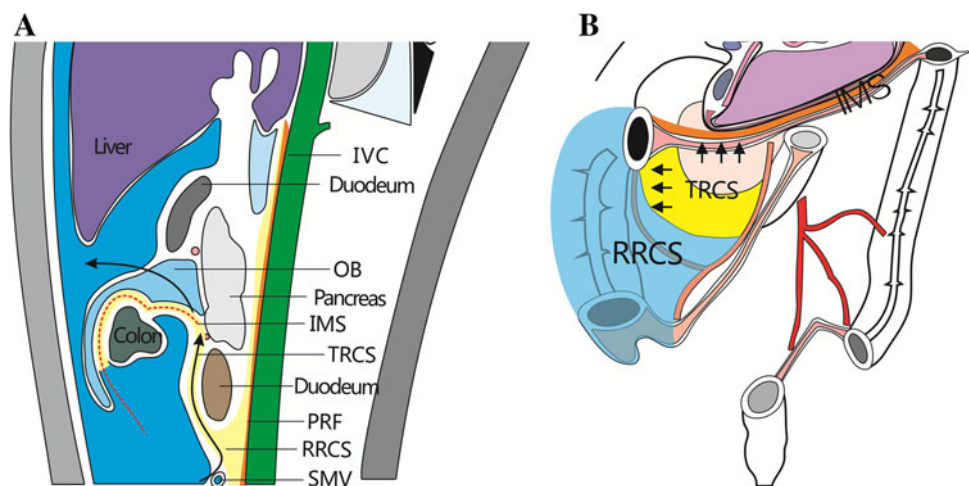
Strategic techniques and difficulties in the CMA

The recognition and extension of the TRCS

The TRCS is located between the transverse mesocolon and the inferior edge of the pancreas. By the inferior margin of the duodenal third portion, the caudal portion of the TRCS extends into the RRCS. By the root of the transverse mesocolon, the cranial portion of the TRCS extends into the IMS. The recognition and extension of the TRCS is one of the most important steps in CMA.

We suggest two possible ways to recognize the TRCS. First, not only is the SMV the boundary between the ascending mesocolon and enteric mesentery, but it is also the middle boundary of and the entrance to the TRCS. Therefore, successful entrance to the TRCS can be achieved after sharp lateral dissection of the ascending mesocolon along the surface of the SMV sheath. Second, the recognition of the ileocolic vessel leads to a successful entrance to the inferior part of the RRCS. The following superior extension enters the TRCS via the dissection of the duodenal third portion and ventral part of the pancreas. Either way can direct into the IMS and the RRCS with

Fig. 3 Anatomy of CMA for CME. **A** IMS commutes with the TRCS posteriorly to the root of the transverse mesocolon. **B** Connection of TRCS with RRCS and IMS in CMA



cranial and right extensions, respectively, to complete the mobilization of the mesocolon.

“Climbing” the inferior edge of the pancreas

CMA requires the bottom-to-top extension of the TRCS that enters the IMS via the root of the transverse mesocolon. Potential complications of the CMA include mistakenly entering the posterior part of the pancreas and hemorrhage caused by the injuries to the pancreas. Therefore, recognizing the inferior edge of the pancreas and “climbing” are key steps. We believe that the emergence of the Henle trunk after the dissection of the SMV suggests that the extension is close to the inferior margin of the pancreas. In the meantime, the extension should convert to a superior direction for the climbing. Also, it is easier to enter the IMS after dissection toward the left of the right gastroepiploic vein, followed by the emergence of the vein.

According to National Comprehensive Cancer Network guidelines and Japanese general rules for clinical and pathological studies on cancer of the colon, rectum, and anus [10], stage I tumor of right hemicolon does not require resection at root of the vessels. In the medical center, preoperative tumor classifications were performed mainly by computed tomography and colonoscopy. The tumor of each patient was thought to be stage II or higher before the operation. Therefore, laparoscopic CME was provided to these patients, even though a few patients in both groups had stage I tumor as confirmed by postoperative pathological examinations (Table 1).

The success of CME to right hemicolon cancer surgery is based on a thorough understanding of embryology and surgical oncology [11]. CMA is technically feasible for laparoscopic CME. It can only take place after properly recognizing the surgical planes and spaces of the right hemicolon under laparoscopic vision. In addition, CMA for laparoscopic CME for the right hemicolon can further reduce operation time and vessel-related complications. This method should be widely encouraged and disseminated.

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