

# The Early Study to Laparoscopic Radical Resection of the Mid Transverse Colon Cancer

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## Abstract

**Objective:** To explore the safety and the short-term curative effect of the application of assisted laparoscopic radical resection for the mid transverse colon cancer. **Methods:** A retrospective analysis of 25 cases clinical data of radical resection of mid transverse colon cancer from March 2006 to March 2014 in our hospital. Cases were divided into two groups, laparoscopic group with 12 cases and open group with 13 cases. Intra-operative observation indexes (operation time, bleeding volume, the number of dissected lymph nodes), post-operative recovery indexes (flatus time, liquid food intake time, ambulation time, hospitalization time), post-operative complication (incision site infection, abdominal bleeding, intra-abdominal infection, anastomotic fistula, intestinal obstruction and re-hospitalization within 30 days, mortality) and patient's five-year overall survival were observed in two groups. **Results:** Operation methods including the principle of complete mesocolic excision (CME), colon dissection along the anatomical plane and safe anastomosis method were applied in Laparoscopic group. Average surgery time of Laparoscopic group was longer than open group, but there was no statistically significant difference between the two groups ( $p > 0.05$ ). Intra-operative blood loss in the Laparoscopic group was obviously lower than open group; the difference was statistically significant ( $p < 0.05$ ). The number of lymph node dissection in laparoscopic group was higher than open group ( $p < 0.05$ ). Laparoscopic group in the postoperative recovery index including recovery of bowel function, ambulation time and hospitalization time was shorter than that of the open group after operation ( $P < 0.05$ ). **Conclusion:** The use of laparoscopic radical resection for the mid transverse colon cancer resulted in acceptable short term curative effects.

## Keywords

Colon Cancer, Clinical Treatment Techniques, Laparoscopy, Mid Transverse Colon Cancer

## 1. Introduction

Colorectal cancer is the most common malignancy of the gastrointestinal tract. Currently surgery is the only possible way to cure colorectal cancer. Since the first laparoscopic colectomy reported in 1991 by Jacobs and Verdeja, minimally invasive colorectal surgery has become more widespread and acceptable, even for malignant disease [1] [2] [3]. Laparoscopic surgery has the advantages of small incision, less post-operative pain, quick recovery and shorter hospital stay [4]-[10]. Mid transverse colon cancer was never included in randomized controlled trials to assess the efficacy of laparoscopic surgery as curative treatment for colon cancer due to difficulty in deciding the appropriate operative procedure and extent of lymph node dissection, as well as technical difficulties with the laparoscopic identification, ligation, and lymph node dissection around the middle colic vessels [11] [12] [13]. However after nearly 20 years of development, the laparoscopic radical operation in colorectal cancer is a considerable progress, especially in the colon. There had been a lot of multi-center prospective randomized controlled studies showing that the laparoscopic radical surgery in colorectal cancer had the same long-term effect as that with open operation, which has been more and more accepted by the surgeons [14] [15] [16]. In our study, 25 patients underwent surgery for the treatment of the mid transverse colon cancer, of which 12 patient underwent assisted laparoscopic radical resection from March 2006 to March 2014. Thus the aim of this study is to assess the short term curative effects of laparoscopic assisted surgery for resection of mid transverse colon cancer.

## 2. Materials and Methods

### 2.1. Clinical Data

Through retrospective analysis of the clinical data of colorectal cancer from March 2006 to March 2014 in our department (Gastrointestinal Surgery, The First Hospital Affiliated to Yangtze University), a total of 414 patients, including 253 cases of colon cancer, 51 cases of transverse colon cancer, were consecutively admitted for operation. Twenty-five cases with carcinoma in the middle of transverse colon were analyzed. 12 cases underwent assisted laparoscopic radical resection (laparoscopic group), 13 cases underwent conventional open radical resection (open group) (Table 1). Post operative systemic chemotherapy was applied to patients with the visceral peritoneum metastasis and regional lymph node metastasis. Pathologic confirmation, colonoscopy, barium enema, computed tomography (CT), ultrasonography, and chest PA were performed for diagnosis in all patients pre-operatively.

Inclusion criteria in this study: 1) radical resection with carcinoma in the middle of transverse colon, 2) pre-operative diagnosis of malignant neoplasm of transverse colon was clear, 3) without distant metastasis through pre-operative examination, 4) R<sub>0</sub> resection by pathological examination.

**Table 1.** The data of patients with radical resection of carcinoma in the middle of transverse colon.

Variable	Laparoscopic group (n = 12)	Open group (n = 13)	P value
Age	54 ± 12	52 ± 12	0.469
Sex (male/female)	5/7	4/9	0.688
Pathological staging (I/II/III)	3/4/5	2/4/7	0.781
Differentiation of adenocarcinoma (poorly/moderately/well)	4/6/2	2/5/6	0.256

Exclusion criteria in this study: 1) the emergency operation case (acute obstruction, perforation), 2) conversion to open surgery due to bleeding or surrounding organs damage during dissection or adhesion of surrounding tissue.

The human subject research review board of our institution approved our study protocol. Before treatment, informed consent was obtained from each patient.

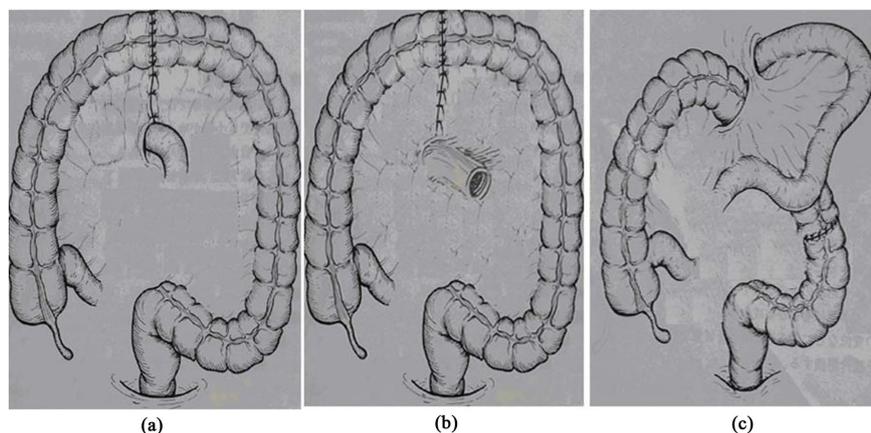
## 2.2. Operation Methods

Both laparoscopic surgery and open surgery strictly follow the tumor radical principle: 1) the complete mesocolic excision (CME) with central vein ligation (CVL) [17] [18], 2) reconstruction of bowel [19]: If the colonic intestine was long enough, direct anastomosis of bowel without tension was done by end-to-end or end to side anastomosis (end to end anastomosis for loose intestinal loop, **Figure 1(a)**). When colonic intestine is slightly tight after intestinal anastomosis, debonding of flexure duodenojejunalis can relieve the oppression to jejunum (additional debonding of flexure duodenojejunalis for slightly tight intestinal loop, **Figure 1(b)**). In the more obese patients or intestinal loop is thick and short bowel patients, in order to reduce the tension of anastomosis and the oppression to jejunum, penetration method (colon to be anastomosed through the small mesenteric root) is performed (penetration method for thick and short intestinal loop, **Figure 1(c)**).

Laparoscopically assisted radical operation:

1) Position of patient: supine, legs apart in order to facilitate the operation. Adjusting the patient position during the operation: reverse trendelenburg position with 20 degree tilt to right side for dissecting hepatic flexure of colon, reverse trendelenburg position with 20 degree tilt to left side for dissecting splenic flexure of colon; reverse trendelenburg position when dissecting transverse colon in the middle.

2) Position of Trocar: using five hole method, put the camera into abdominal cavity through 12 mm Trocar below the umbilicus, the remaining four holes are respectively placed in the left anterior axillary line 2 cm below the subcostal region with 12 mm trocar and left midclavicular line at level of umbilicus with 5 mm Trocar, the position of right upper and right lower trocar to the corresponding left side, using 5 mm Trocar. But during surgery the position of trocar



**Figure 1.** Reconstruction of bowel.

can be adjusted according to the location of tumor. Pneumoperitoneum is induced with CO<sub>2</sub> at 12 mmHg.

3) The dissecting process starts with vascular root: After abdominal cavity is explored, greater omentum and transverse colon are pushed to the side of head, small intestine is pushed to the left abdominal cavity, then the mesenteric root is exposed, peritoneal incision is commenced with dissection along the superior mesenteric vein up to the inferior margin of pancreas. Middle colic artery, a branch of superior mesenteric artery, usually found in inferior margin of pancreas is clipped with Ham-Lock clamp and transected at the root along with the middle colic vein. Lymph nodes of the anterior aspect of superior mesenteric vein from middle colic vessels to the gastro-colic trunk of Henle are dissected. A fascial plane between the mesocolon and the underlying retroperitoneum, formed by the fusion of the visceral peritoneum of the mesocolon with the parietal peritoneum of the retroperitoneum is known as Toldt's fascia [20]. During the surgery, dissection along the plane between the intact dorsal mesocolon of the hepatic flexure and the Fredet preduodenopancreatic fascia was done. Then, dissection was done along the duodenal plane into the pancreatic surface, turning left along the pancreatic surface into lesser sac, exposing the tail of the pancreas and the lower pole of the spleen. From the middle of the gastrocolic ligament, besides gastroepiploic vessels arch, greater omentum was dissected towards the hepatic flexure of colon and splenic flexure of colon respectively. Hepatic flexure was mobilized by dissecting the lateral peritoneal fold, the superior attachment (right phrenocolic ligament), and the medial attachment (cholecysto-duodeno-colic ligament). Splenic flexure is mobilized by dissecting the gastrocolic and splenocolic ligament.

4) Resection and Anastomosis: Once the colon was completely mobilized, an incision of about 5 - 6 cm was made in the mid line of the upper abdomen. Incision protractor was used. Then the mass was extracted along with the colon. En bloc resection of mass with the omentum and mesentery lymph nodes was done. A stapled colo-colic anastomosis was done with either end-to-end or end-to-side anastomosis.

5) The colon was then placed back into the abdomen and extraction site was closed. CO<sub>2</sub> was reinsufflated to create pneumoperitoneum, operated area was irrigated with saline water. The drainage tube was placed nearby foramen of Winslow. Open operation was done with the same method with middle approach, which was same to laparoscopic group.

### 2.3. Observation Indexes

1) Intra-operative observation indexes: operation time, bleeding volume, the number of dissected lymph nodes.

2) Post-operative recovery indexes: flatus time, liquid food intake time, ambulation time, hospitalization time.

3) Post-operative complication: complication that develops as any adverse event after treatment, including incision site infection, abdominal bleeding, intra-abdominal infection, anastomotic fistula, intestinal obstruction and re-hospitalization within 30 days. Treatment mortality is defined as any death within 30 days of the treatment.

4) Follow-up: Patient's five-year overall survival observed. Post-operative follow-up: every 3 - 6 months for 2 years, then every 6 months for a total of 5 years.

### 2.4. Statistical Analysis

Continuous data were expressed as range and the mean  $\pm$  SD and were compared between groups by using the Independent-Samples T Test. Categorical variables were compared by using the  $\chi^2$  test. Overall survival was computed by using the Kaplan-Meier method and was compared between the two groups by using the log-rank test. All statistical analyses were performed with the SPSS statistical package (SPSS 20.0 for Windows). A P value  $< 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Patient Characteristics

The baseline characteristics of the patients in both groups are shown in **Table 1**. The two groups were similar in age and sex distribution. There was no significant difference between the groups in Pathological staging and differentiation of adenocarcinoma (poorly/moderately/well by using 2010 World-Health-Organization criteria [21]).

### 3.2. Intra-Operative Observation Indexes

The Intra-operative observation indexes are shown in **Table 2**. In laparoscopic group, 12 patients were successfully performed assisted laparoscopic radical resection for mid transverse colon cancer, without conversion to laparotomy. Operation time was 200 - 300 min ( $230 \pm 28.60$  min), the bleeding volume was 50 - 150 ml ( $89.58 \pm 32.99$  ml), intra-operative dissected lymph nodes number were 15 - 39 pieces ( $22.25 \pm 6.48$ ). In Open group, 13 patients were successfully

**Table 2.** Comparison of operation time, intra-operative bleeding volume and the number of dissected lymph nodes in laparoscopic group with open group.

Variable	Laparoscopic group (n = 12)	Open group (n = 13)	P value
operation time (min)	230.00 ± 28.60	213.85 ± 33.55	0.210
bleeding volume (ml)	89.58 ± 32.99	133.46 ± 44.51	0.011
number of lymph nodes (n)	22.25 ± 6.48	17.53 ± 3.75	0.035

performed open radical resection for mid transverse colon cancer. Operation time was 160 - 270 min ( $213.85 \pm 33.55$ min), the bleeding volume was 70 - 200 ml ( $133.46 \pm 44.51$  ml), intra-operative dissected lymph nodes number were 13 - 25 pieces ( $17.53 \pm 3.75$ ). Operation time in laparoscopic group was longer than the open surgery group, but there was no significant difference in two groups ( $p > 0.05$ ). Intra-operative bleeding volume in laparoscopic group was obviously less than the open group ( $p < 0.05$ ). The number of dissected lymph nodes were more than open surgery group ( $p < 0.05$ ).

### 3.3. Post-Operative Recovery Indexes

The post-operative recovery indexes are shown in **Table 3**. Post-operative flatus time, liquid food intake time, ambulation time and hospitalization time in laparoscopic group were 2 - 5 d ( $3.00 \pm 1.12$  d), 3 - 6 d ( $3.91 \pm 0.99$  d), 1 - 6 d ( $3.33 \pm 1.43$  d) and 7 - 11 d ( $9.50 \pm 1.24$  d) respectively. Post-operative flatus time, liquid food intake time, ambulation time and hospitalization time in open group were 3 - 7 d ( $4.76 \pm 1.16$  d), 4 - 8 d ( $5.00 \pm 1.15$  d), 3 - 7 d ( $4.61 \pm 1.12$  d) and 10 - 16 d ( $12.00 \pm 1.82$  d) respectively.

Index of post-operative recovery in laparoscopic group including post-operative flatus time, liquid food intake time, ambulation time and hospitalization time were shorter than the open group ( $P < 0.05$ ).

### 3.4. Post-Operative Complications

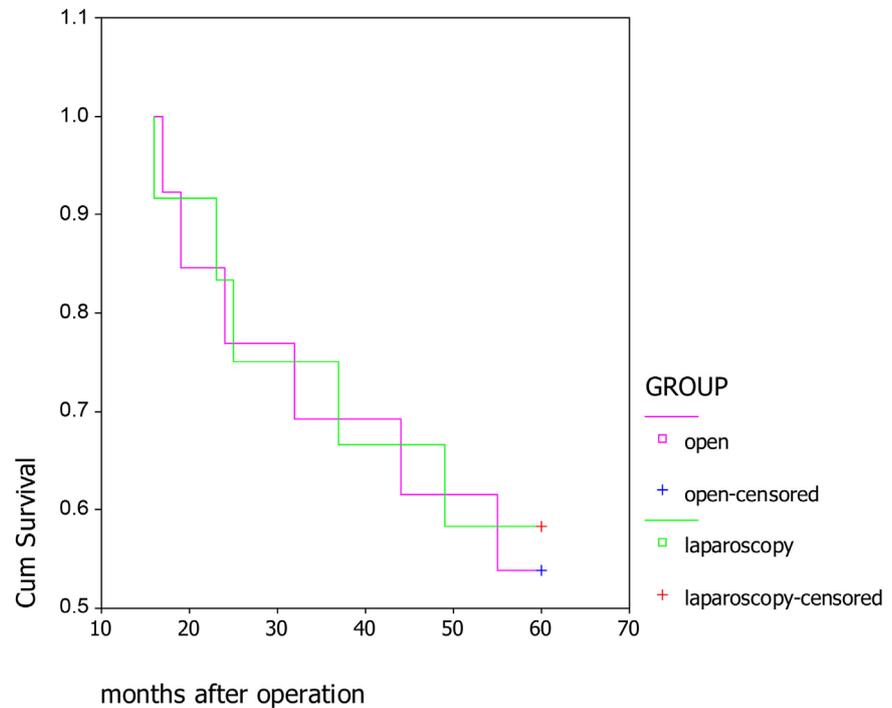
One case with post-operative incision site infection was found in open group. Abdominal bleeding, intra-abdominal infection, anastomotic fistula, intestinal obstruction weren't found in two groups. There wasn't re-hospitalization and dead case in 30 d post-operative period in two groups.

### 3.5. Follow-Up Results

Five patients (41.7%) in laparoscopic group and six patients (46.2%) in open group had died in 5-year follow-up. **Figure 2** depicts the cumulative five-year overall survival curves, which were not significantly different between two groups ( $P = 0.8547$ ).

## 4. Discussion

After laparoscopic colon resection first reported in 1991 [1], laparoscopic surgery has been widely employed for various benign colorectal disease such as



**Figure 2.** Kaplan-Meier curve comparing the cumulative five-year overall survival of patients of laparoscopic group (n = 12) and open group (n = 13).

**Table 3.** Comparison of post-operative flatus time, liquid food intake time, ambulation time and hospitalization time in laparoscopic group and open group.

Variable	Laparoscopic group (n = 12)	Open group (n = 13)	Pvalue
Flatus time (d)	3.00 ± 1.12	4.76 ± 1.16	0.001
liquid food intake time (d)	3.91 ± 0.99	5.00 ± 1.15	0.020
ambulation time (d)	3.33 ± 1.43	4.61 ± 1.12	0.020
hospitalization time (d)	9.50 ± 1.24	12.00 ± 1.82	0.001

benign mass [22], diverticular disease [23], inflammatory bowel disease [24], rectal prolapsed [25], and now increasingly for colorectal malignant disease [14] [15] [16]. Transverse colon cancer accounts for about 10% of cases of colorectal cancer, and the laparoscopic approach to oncological resection is a challenging task. Radical resection with laparoscopic assisted surgery for transverse colon cancer is difficult due to its special anatomical site, its proximity with adjacent structures such as pancreas, duodenum, spleen and the base of mesenteric vessels making it difficult for dissection and also the technical difficulties with laparoscopic identification, ligation, and lymph node dissection around the middle colic vessels. Because of these reasons, transverse colon cancer was excluded from almost every prior prospective randomized trial [11] [12] [13]. As experiences of laparoscopic surgery are accumulating and surgical techniques and instruments are developing, we consider that the extent of laparoscopic lymph node dissection for transverse colon cancer is not less than the extent of conventional lymph node dissection for transverse colon cancer.

In our study from March 2006 to March 2014, we had analyzed 25 cases of patients with mid transverse colon cancer treatment. Laparoscopic assisted surgery for mid transverse colon cancer group had less intra operative bleeding, greater range of lymph node dissection as compared with open surgery group and the operation time in laparoscopic assisted surgery group was slightly longer than that with the open surgery group, but the difference was not statistically significant. The post-operative ambulation time, recovery of bowel function time, hospitalization time and the complication rates were significantly lesser in laparoscopic assisted surgery group as compared to the open group. Laparoscopic assisted transverse colon cancer surgeries are technically difficult, requiring facility with numerous surgical techniques and abilities to perform a diversity of procedures. For proximal transverse tumors or tumors at hepatic flexure, an extended right hemicolectomy is performed. Similarly, for distal transverse tumors, even at the splenic flexure, an extended left hemicolectomy is performed and for mid-transverse colon cancer transverse colectomy is performed. In this study, through a retrospective analysis, we explore the skill of laparoscopic assisted radical resection of mid transverse colon cancer. During the laparoscopic assisted surgery for mid transverse colon cancer, firstly we followed the concept of Laparoscopic complete mesocolic excision (CME) with central vein ligation (CVL). The concept of complete excision of the organ within its primitive mesentery associated with central transection of the supplying blood vessels is today considered the step toward a modern surgical oncology, as the no-touch resection of the primitive embryological dorsal mesentery is pivotal in achieving optimal local clearance. Furthermore, some studies suggested that CVL allows for an extensive lymph node clearance along the feeding vessels of the colon, with definitive effect on regional recurrence and systemic dissemination [26] [27]. Laparoscopic CME with CVL demonstrated not only superior oncologic efficacy but also to be absolutely safe, without increase in morbidity and mortality, with the addition of all the advantages of minimally invasive techniques [26]-[31]. Secondly, after resection of the mass the remaining bowel should be anastomosed for the continuity of bowel without any tension. It has been stated that “the key to a successful anastomosis is the accurate union of two viable bowel ends with complete avoidance of tension” [32]. Thus, the most important factors in the creation of a bowel anastomosis are: 1) meticulous technique; 2) good blood supply; and 3) no tension. During laparoscopic radical colon surgery, both hepatic flexure and splenic flexure of transverse colon are mobilized for a tension free anastomosis of remaining bowel. In our study: If the intestine was long enough, direct anastomosis of bowel without tension was done by end-to-end or end to side anastomosis. When colonic intestine is slightly tight after intestinal anastomosis, debonding of flexure duodenojejunalis can relieve the oppression to jejunum. There were 1 patients through debonding of flexure duodenojejunalis, relieve the oppression to jejunum, the prognosis is good. In the more obese patients or intestinal loop is thick and short bowel patients, in order to reduce the tension of anastomosis and the oppression to jejunum, pe-

netration method (colon to be anastomosed through the small mesenteric root) is performed. The group also in 1 patient after the treatment, the prognosis is good. In addition, laparoscopic assisted transverse colon cancer operation, need surgery and assistants with skilled operation team, who have laparoscopic operation experience of the gastric, right and left colon cancer.

## 5. Conclusion

With good laparoscopic surgical skill, mid transverse colon cancer patient treated with laparoscopic assisted surgery has obvious advantages of the fine operation with curative resection and better clearance of lymph nodes. Laparoscopic assisted surgery group had less bleeding during the operation, the advantages of quick recovery after operation, without increasing the risk and complications.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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