Laparoscopic versus open resection for transverse colon cancer

Massimiliano Mistrangelo,Marco Ettore Allaix,Paola Cassoni,Giuseppe Giraudo,Simone Arolfo,Mario Morino
Laparoscopic versus open resection for transverse colon cancer
SURGICAL ENDOSCOPY (2015) 29(8):2196-2202
DOI: 10.1007/s00464-014-3921-z

Laparoscopic versus open resection for transverse colon cancer

Massimiliano Mistrangelo[1] , Marco Ettore Allaix[1], Paola Cassoni[2], Giuseppe Giraudo[1], Simone Arolfo[1] and Mario Morino[1]
(1)
Digestive and Colorectal Surgical Department, Città della Salute e della Scienza di Torino Hospital, Centre of Minimal Invasive Surgery, University of Turin, Corso A. M. Dogliotti, 14, 10126 Turin, Italy
(2)
Department of Biomedical Sciences and Human Oncology, Città della Salute e della Scienza di Torino Hospital, Turin, Italy

Abstract

Background

Previous large randomized controlled trials comparing laparoscopic (LR) and open resection (OR) for colon cancer have not specifically analyzed the outcomes in patients with transverse colon cancer. The aims of this study were to evaluate the feasibility and safety of LR transverse colon cancer resection and to compare our findings with the results available in the literature.

Methods

We performed a retrospective analysis of consecutive patients undergoing LR or OR for histologically proven adenocarcinoma of the transverse colon.

Results

A total of 123 patients were included in this study: 66 LR and 57 OR. Median operating time was similar in the two groups. Median blood loss was higher in the OR group, even though the difference was not statistically significant. The rate of conversion from LR to OR was 16.7 %. Return of bowel function occurred significantly earlier in the LR group. The incidence and severity of 30-day postoperative complications and mortality rates were similar in the two groups. The median hospital stay was significantly shorter in the LR group. There was a trend toward a greater number of lymph nodes harvested in the OR group than in the LR group, although the difference was not statistically significant. The time to first flatus and bowel movement was significantly earlier in the LR group. Five-year overall survival and disease-free survival rates were similar in the LR and OR groups (86.4 vs. 88.6 %, $p = 0.770$ and 80.4 vs. 77.3 %, $p = 0.516$, respectively).

Conclusions

LR of transverse colon cancer is feasible and safe, with similar early short-term outcomes when compared to OR. Larger prospective comparative studies with long-term follow-up are needed to assess the oncological equivalence of the two approaches.

Keywords

Transverse colon cancer Laparoscopic surgery Open surgery Outcomes

Since the first laparoscopic-assisted colon resections were published in 1991 [*1*–*3*], many studies have demonstrated the short-term benefits of the laparoscopic (LR) approach to several benign and malignant colorectal diseases. However, despite its proven benefits and oncologic equivalence, laparoscopic colorectal resection has been slow to gain acceptance.

In 2005, Schwenk et al. [*4*] published the first Cochrane Review on the short-term benefits of LR colorectal resection, suggesting that laparoscopy is superior to open surgery in terms of reduction in blood loss and postoperative pain, improved pulmonary function, shorter duration of postoperative ileus and length of hospital stay, and enhanced quality of life in the early postoperative period. Furthermore, the risk of postoperative morbidity in patients undergoing LR resection was lower [*4*].

In another Cochrane review published in 2008, Kuhry et al. [*5*] compared the long-term results of LR colorectal surgery. They confirmed that LR colon cancer resection is a safe procedure associated with a survival rate equal to that of open surgery and that there is a trend toward lower overall mortality after laparoscopically-assisted procedures [*5*]. They concluded that, because the majority of previous trials comparing LR and open surgery for colon cancer had excluded obese patients and did not analyze separately those with transverse colon tumors, there was a need for new studies including such patient subpopulations [*5*].

The last 10 years have witnessed a trend of increasing utilization of LR surgery for colon cancer [*6*], and some small studies with short follow-up have compared the outcomes of LR and open resection (OR) in patients with transverse colon cancer [*7*–*16*].

Simorov and Coll [*6*] examined 85,712 discharge records from the patients undergoing LR or open colon resection. Patients were identified during the study period of October 2008 to December 2011. They observed that the overall rate of LR colectomy was 42.2 % [*4*]. The overall conversion rate for LR to open procedure was 15.8 % [*4*].

The aim of this study was to evaluate the outcomes of LR of transverse colon cancer and to compare our findings with the results available in the literature.

Materials and methods

This study is a retrospective analysis of a prospective database of patients who had undergone LR or OR for both benign and malignant colonic diseases. All consecutive patients undergoing LR or OR for histologically proven adenocarcinoma of the transverse colon at our department between April 1998 and April 2011 were identified. Exclusion criteria were acute intestinal obstruction, perforation, acute bleeding, or absolute contraindications to general anesthesia. Transverse colon cancer was defined as tumor located between the hepatic and splenic flexure.

Three surgeons performed all LRs or ORs. Tumors with preoperative evidence of invasion of adjacent organs (e.g., the spleen or pancreas) were treated with OR. In both groups, all procedures were performed following the same oncologic principles: adequate resection margins, “en—bloc” vascular resection, lymphadenectomy, and minimal intraoperative manipulation of the tumor.

A tumor located at the hepatic flexure or within 10 cm distal to the hepatic flexure was treated by extended right hemicolectomy; a tumor at the splenic flexure or within 10 cm proximal to the splenic flexure was treated by segmental colon resection or left extended hemicolectomy. Transverse colectomy was performed for tumor located centrally in the transverse colon.

LR resections were performed using four trocars (two 5-mm trocars, one 10-mm trocar, and one 10–12-mm trocar). A further 5-mm trocar was placed under the xiphoid process in selected cases. The trocars' position changed according to the location of the tumor and therefore to the type of planned resection. During LR, the specimen was extracted in a wound protector through a small incision, performed either suprapubic or in the right or left abdominal upper quadrants.

Preoperative work-up was standardized for both groups and included physical examination, total colonoscopy with biopsies, abdominal computed tomography (CT), chest X-ray, and carcinoembryonic acid (CEA) and CA-19.9 assay.

Preoperative endoscopic tattooing was performed if the radiological localization of the tumor by CT scan was unclear.

Preoperative and postoperative management was also standardized for both groups. Preoperative mechanical bowel preparation was used until 2005. Intravenous antibiotics were administered before incision and continued for 5 days after the operation.

Low-molecular-weight heparins were administered for deep venous thrombosis prophylaxis. Postoperative analgesia was achieved with intravenous local anesthetics (bupivacaine) for 48 h and parenteral nonsteroidal analgesics. Oral intake was started on the day after the first flatus occurred. The following parameters were entered into the database: patient characteristics [age, gender, American Society of Anesthesiology (ASA) score, tumor site, and location of metastases]; operative variables; pathological data; short-term outcomes; and oncological outcomes.

Operative variables included operating time (from skin incision to dressing application), intraoperative morbidity, and conversion rate. Conversion from LR to OR was defined as an unplanned incision or an incision performed longer than that was necessary for specimen retrieval or earlier than that planned. Pathological data included tumor size, number of lymph nodes harvested, and surgical resection margins. Short-term outcomes included resumption of gastrointestinal function, length of hospital stay, and morbidity and mortality rates within 30 days after surgery.

Adjuvant chemotherapy was offered to patients after a clinical oncologic evaluation within 6 weeks after surgery. Indications, protocols, and regimens of administered adjuvant chemotherapy did not differ between the two groups. All patients were followed up prospectively with clinical examination and serum CEA and CA 19-9 blood tests every 3 months and liver ultrasound every 6 months for the first 2 years, then annually. Chest X-ray and abdominal CT scans were obtained every year. Colonoscopy was performed at 12 months after surgery and then every 3 years. Long-term oncologic data included local recurrence rate, incidence of abdominal wall and distant metastases, overall survival, and disease-free survival and were collected prospectively from the time of diagnosis of the primary tumor.

Statistical analysis

Quantitative data are given as median and range. Chi-square tests were used to compare proportions. Student's *t* test was used to compare normally distributed variables. Univariate

analyses of overall survival rate were performed using the Kaplan–Meier method, and the differences between the groups were evaluated with the log-rank test. Patients' observations were censored on the date of last examination or death. All analyses were performed on an intention-to-treat basis: patients who had LR converted to OR were included in the LR group. A level of 5 % was set as the criterion for statistical significance. The data were collected on an Excel spreadsheet. Statistical analysis was performed using SYSTAT Version 10 (SPSS Inc., Chicago, IL).

Results

Between April 1998 and April 2011, 1,372 colon cancer patients were admitted to our Institution. Ninety-eight of them underwent an emergency procedure because of obstruction, bleeding, or perforation. Of the remaining 1,274 consecutive patients who underwent elective colonic resection, 123 (9.7 %) had transverse colon cancer: 66 were treated by LR and 57 underwent OR.

There were no significant differences in age, sex distribution, body-mass index, ASA score, and type of surgical procedure in the two groups (Table 1).

Table 1

Baseline characteristics

	LR (*N* = 66)	**OR (*N* = 57)**	***p* value**
Gender			
Male—no. (%)	32 (48.5)	33 (57.9)	0.389
Age (years)			
Median (range)	68 (37–90)	70 (49–90)	0.353
ASA status—no. (%)			
I	21 (31.8)	17 (29.8)	0.966
II	34 (51.5)	27 (47.4)	0.781
III	10 (15.2)	11 (19.3)	0.712
IV	1 (1.5)	2 (3.5)	0.898
BMI (kg/m^2)			
Median (range)	24 (21–30)	24.5 (20–31)	0.735
Procedure—no. (%)			
Right hemicolectomy	12 (18.2)	14 (24.6)	0.520
Transverse colon resection	39 (59.1)	27 (47.4)	0.263
Left hemicolectomy	15 (22.7)	16 (28)	0.637

LR laparoscopic group, *OR* open group

Intraoperative results

The median operative time was 120 (range, 60–240) min in the LR group and 125 (range, 70–225) min in the OR group ($p = 0.569$). Median estimated blood loss was lower in the OR group, although the difference was not statistically significant (75 vs. 100 ml; $p = 0.087$).

No intraoperative complications occurred in either group. There were 11 (16.7 %) conversions from LR to OR because of locally advanced cancer in six cases (54.5 %), obesity and inability to locate the tumor in three cases, and portal hypertension in two cases.

Postoperative results

Return of bowel function and resumption of solid diet occurred significantly earlier in the LR group (Table 2).

Table 2

Postoperative results

	LR (*N* = 66)	**OR (*N* = 57)**	***p* value***
30-day morbidity—no. (%)	9 (13.6)	11 (19.3)	0.546
Bleeding	2 (3)	1 (1.7)	
Anastomotic leakage	1 (1.5)	2 (3.5)	
Prolonged ileus	2 (3)	2 (3.5)	
Cardiovascular	0	3 (5.3)	
Pulmonary	2 (3)	2 (3.5)	
Pancreatic fistula	1 (1.5)	1 (1.7)	
Evisceration	1 (1.5)	0	
Reoperation—no. (%)	1 (1.5)	2 (3.5)	0.898
30-day mortality—no. (%)	1(1.5)	2 (3.5)	0.898
Acute respiratory distress syndrome	1	0	
Acute myocardial infarction	0	1	
Acute respiratory failure	0	1	
Time to mobilization (days)			
Median, range	2 (1–5)	3 (2–6)	<0.001*
Time to first flatus (days)			
Median, range	2 (1–5)	4 (2–10)	<0.001*
Time to first bowel movement (days)			
Median, range	4 (2–6)	5 (2–12)	<0.001*
Time to oral intake (days)			
Median, range	4 (2–7)	5 (3–12)	<0.001*
Hospital stay (days)			
Median, range	7 (5–18)	10 (6–60)	<0.001*
Long-term morbidity—no. (%)			
Anastomotic stricture	1 (1.5)	0	0.941

LR laparoscopic group, *OR* open group

* LR versus OR

The incidence (12.7 vs. 19.3 %; $p = 0.437$) and severity of 30 day postoperative complications according to Dindo's classification were similar between the two groups. No significant differences were observed in the mortality rate between the two groups (1.4 vs. 3.5 %; $p = 0.847$). The median length of hospital stay was significantly shorter in the LR group (7 days, range 5–18, vs. 10 days, range 6–60; $p < 0.001$).

Pathological results

The specimen was significantly longer in the OR group (27.5 vs. 23 cm; $p = 0.021$). There was a trend toward a greater number of lymph nodes harvested in the OR group than in the LR group (13.5 and 12 lymph nodes, respectively), although the difference was not statistically significant ($p = 0.149$).

Table 3 summarizes the tumor stage distribution according to the TNM classification in the two groups.

Table 3

Pathological findings

	LR (*N* = 66)	**OR (*N* = 57)**	***p* value***
Length of specimen (cm)			
Median, range	23 (6.5–75)	27.5 (9–63.5)	0.021
Lymph nodes harvested—no.			
Median, range	12 (2–28)	13.5 (2–34)	0.149
TNM Tumor stage—no. (%)			
I	15 (22.7)	9 (15.8)	0.459
II	25 (37.9)	26 (45.6)	0.391
III	18 (27.3)	13 (22.8)	0.865
IV	8 (12.1)	9 (15.8)	0.745
T1	11 (16.7)	2 (3.5)	0.038
T2	7 (10.6)	7 (12.3)	0.780
T3	43 (65.2)	31 (54.4)	0.391
T4	5 (7.6)	17 (29.8)	0.003

LR laparoscopic group, *OR* open group

* LR versus OR

Follow-up

The mean duration of follow-up was 67 months (range 24–156) in the LR group and 71 months (range 24–156) in the OR group ($p = 0.136$).

Disease-free survival rate at 5 years was 80.4 % in the LR group and 77.3 % in the OR group (p = 0.516) (Fig. 1).

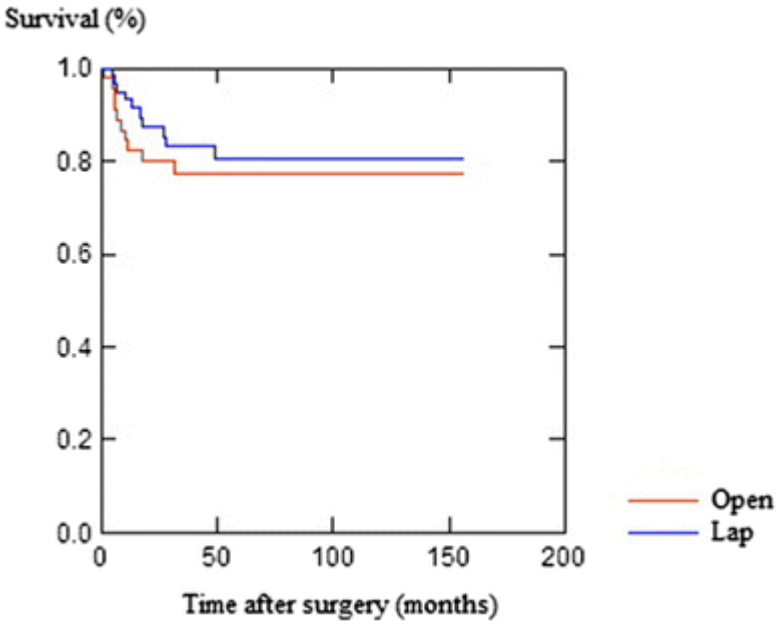

Fig. 1

Disease-free survival at 5 years

Overall survival rate at 5 years was 86.4 % in the LR group and 88.6 % in the OR group. (p = 0.770) (Fig. 2).

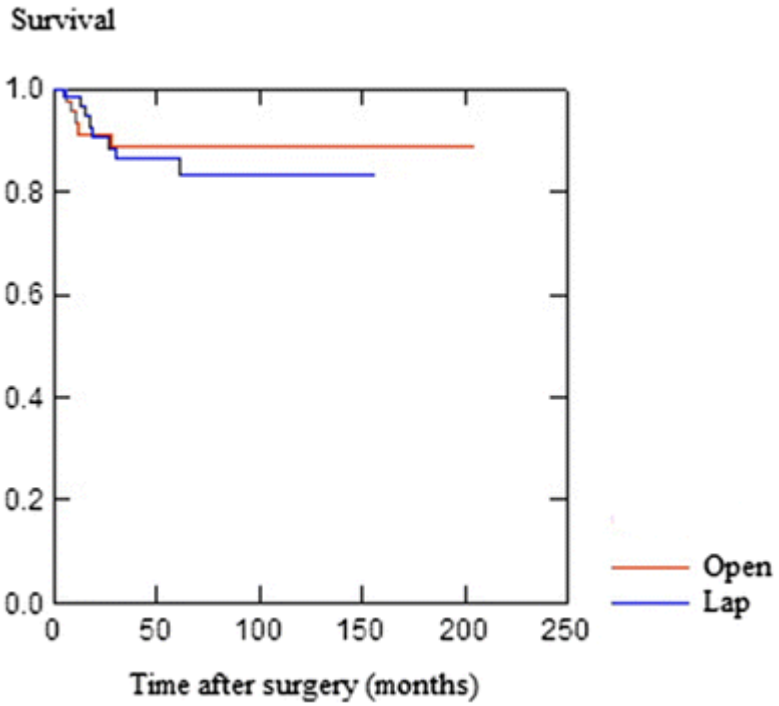

Fig. 2

Overall survival at 5 years

Preoperative, intraoperative, and postoperative findings reported in this manuscript are compared with the results available in the literature (Tables 4, 5, 6, 7).

Table 4

Preoperative data from the literature

Author	No. of patients		Surgical procedure				BMI (kg/m^2)	
	LAP	OPEN	RH	RT	LH	O	LAP	OPEN
Schlachta [9]	22	n.r.	12	09	01	0	27.4	n.r.
Kim [10]	37	50	23/23	06/15	08/12	0	23.2	23.1
Akiyoshi [11]	53	39	29/27	12/05	12/07	0	22.7	21.7
Zmora [7]	22	24	12/20	03/0	07/04	0	n.r.	n.r.
Nakashima [12]	33	22	0/0	0/0	26/18	7/4	22.8*	20.8*
Yamamoto [13]	200	45	26/04	29/20	44/10	0	22	21
Fernández [14]	34	52	15/26	03/06	12/08	4/12	24.2	24.1
Present study	66	57	12/14	39/27	15/16	0	24	24.5

In the surgical procedure column where two numbers are given, the first refers to laparoscopic and the second to open procedures

LAP laparoscopic group, *OPEN* open group, *RH* right hemicolectomy, *RT* transverse resection, *LH* left hemicolectomy, *O* other procedures, *n.r.* not reported

* Statistically significant

Table 5

Intraoperative and pathological data from the literature

Author	Operating time (min)		Conversion to open—no. (%)	Blood loss (ml)		LFN	
	LAP	OPEN		LAP	OPEN	LAP	OPEN
Schlachta [9]	209	n.r.	4 (18.2)	n.r.	n.r.	15.3	n.r.
Kim [10]	202.6	199.5	n.r.	113.8*	278.8*	26.1	22.7
Akiyoshi [11]	224*	157*	1 (1.9)	40*	79*	17*	23*
Zmora [7]	265*	147*	1 (5)	237*	521*	16.2	16.8
Nakashima [12]	209	178	1 (3)	15*	113*	16	12
Yamamoto [13]	236.6	185.7	11 (11.1)	10*	130.7*	15.4	16
Fernández [14]	215.4	199.3	1 (2.9)	105.9*	305.7*	16.2	14.2
Present study	120	125	11 (16.6)	75	100	12	13.5

LAP laparoscopic group, *OPEN* open group, *n.r.* not reported, *LFN* no. of lymph nodes

* Statistically significant

Table 6

Postoperative outcome: data from the present study and the literature

Author	Time to flatus (days)		Time to oral intake (days)		Hospital stay (days)	
	LAP	OPEN	LAP	OPEN	LAP	OPEN
Schlachta [*9*]	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Kim [*10*]	2.8*	4.4*	3.9*	5.4*	11.0	11.2
Akiyoshi [*11*]	1.7*	2.5*	2.4*	5.3*	12*	15*
Zmora [*7*]	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Nakashima [*12*]	1*	3*	2*	5*	12*	16*
Yamamoto [*13*]	n.r.	n.r.	4.5*	7*	11.4*	30.1*
Fernández [*14*]	2.1*	3.8*	3.1	3.4	7.1	7.3
Present study	2*	4*	4*	5*	7*	10*

LAP laparoscopic group, *OPEN* open group, *n.r.* not reported

* Statistically significant

Table 7

Postoperative complications: data from the present study and the literature

Author	Complications—no. (%)		Dehiscence—no. (%)		Mortality—no. (%)	
	LAP	OPEN	LAP	OPEN	LAP	OPEN
Schlachta [*9*]	9 (45)	n.r.	0	n.r.	1 (4.5)	n.r.
Kim [*10*]	2 (5.3)	4 (8)	0	0	0	0
Akiyoshi [*11*]	5 (9.4)	3 (7.7)	0	0	0	0
Zmora [*7*]	17 (78)	13 (53.5)	1 (4.5)	1 (4)	n.r.	n.r.
Nakashima [*12*]	2 (6)*	8(36)*	0	0	0	0
Yamamoto 2012	18 (18.2)	11 (32.3)	2 (2)	3 (8.8)	1 (1)	1 (2.9)
Fernández 2012	6 (17.6)	8 (15.4)	1 (2.9)	1 (1.9)	0	0
Present study	9 (12.7)	11 (19.3)	1 (1.4)	2 (3.5)	1 (1.4)	2 (3.5)

LAP laparoscopic group, *OPEN* open group, *n.r.* not reported

* Statistically significant

Discussion

Several large multicenter prospective randomized controlled trials (COST, COLOR, CLASSIC, and Barcelona) have demonstrated that LR for colon cancer achieves excellent short-term outcomes and equivalent long-term oncologic results when compared to OR [17–21]. Cochrane database reviews confirmed these reports [4, 5]. However, subgroup analyses of patients with transverse colon cancer were not performed.

Main reasons are the low incidence of transverse colon cancer (about 10 %), and technical problems related to a) the challenging localization of the neoplasm, isolation and ligation of the middle colic vessels, especially in obese patients, and b) lymphadenectomy at this level by using the LR approach. In addition, anatomical features of the transverse colon (flaccid, mobile, not fixed to retroperitoneal structures) and its relationships with the spleen, pancreas, superior mesenteric vein, duodenum, and Treitz ligament make transverse colon mobilization and dissection a challenging procedure even in very expert hands. The dissection in different quadrants of the abdominal cavity, combined with the mid-abdominal location of the middle colic vessels, poses a challenge in the proper positioning of the camera and working ports [7]. In addition, excessive traction on the transverse mesocolon during the dissection of the middle colic vessels may cause bleeding [8].

Several studies have compared LR and OR for transverse colon cancer; however, the interpretation of the results is limited by the small number of patients included in the studies and the short follow-up.

We have analyzed both short-term and oncologic long-term outcomes in 123 transverse colon cancer patients with a median follow-up of 67 (LR) and 71 (OR) months.

Table 5 summarizes the intraoperative outcomes of LR and OR [7, 9–14]. While most studies already published in the literature report a significantly longer operative time in the group of patients who had undergone LR than OR, [7, 11, 13], we did not observe significant differences between the two groups, most likely because almost all LR were performed by a single surgeon (M. Mo.), with extensive experience in colorectal and LR surgery.

The conversion rates from LR to OR reported in the literature range between 1.9 and 18.2 %. We found a conversion rate of 16.6 %; the main reason for conversion was a bulky tumor. Estimated blood loss is significantly lower in patients undergoing LR in almost all studies. We observed reduced blood loss in the LR group that did not reach the statistical significance, mainly due to the relatively small sample size. The number of lymph nodes harvested is similar after LR and OR [4, 5].

In our series, the specimen was significantly longer in the patients undergoing OR (27.5 vs. 23 cm; $p = 0.021$). This variable was not evaluated in the other studies which, instead, reported mean proximal and distal resection margins, with no significant differences between the two approaches [7, 9, 11–14]. Only Kim et al. [10] found a mean distal margin of 12.5 cm in the LR versus 9.2 cm in the open surgery group ($p < 0.05$).

Table 6 summarizes the short-term postoperative outcomes of LR and OR [7, 9–14]. Return of bowel function [10–12, 14] and resumption of solid diet occurred significantly earlier in the LR patients [10–13], with a significantly shorter length of hospital stay than OR patients [11–13]. Otherwise, Lohsiriwat [22] suggested that the time to discharge is also influenced by many other factors.

Postoperative complications and mortality rates are similar in the two groups (Table 7) [7, 9–14]. Only Nakashima [12] reported a significantly lower rate of postoperative complications in the LR.

On the basis of our results and the published data, the LR approach to transverse colon cancer is feasible and safe, with reduced intraoperative blood loss and similar operative time (if performed by expert surgeons) when compared to the open approach. It is safe, with morbidity and mortality rates that are similar to those observed after OR. However, it is a challenging procedure. The patients' selection is key.

Yamamoto et al. [*23*] retrospectively investigated the risk factors of conversion to open surgery in 1,701 patients who had undergone LR resection of the colon and the rectum. They found that the significant risk factors for conversion to open surgery were T stage ≥ 3, previous abdominal surgery with median incision, upper median incision, lower median incision, and transverse colectomy (OR 1.76). Similarly, Lu et al. [*24*] reported an OR of 1.66 for transverse colectomy as a statistically significant predictor of conversion from LR to open surgery in a multivariate analysis.

In addition, the evidence currently available shows similar oncologic results after LR and OR. For instance, Fernández-Cebrián [*14*] reported a 3-year cumulative overall survival rate of 78 % and a disease-free survival rate of 69 % in 86 (34 LR and 52 OR) patients, with no significant differences in these cancer-specific end-points between the two groups.

Hahn et al. [*16*] recently published the long-term oncologic results after LR transverse colon cancer resection in 58 patients with a mean follow-up of 40.5 months, reporting overall and disease-free survival rates at 5 years of 84.6 and 89.3 %, respectively. These are similar to those observed in our series: the overall and disease-free survival rates at 5 years were 86.4 and 80.4 %, respectively. Yamamoto [*13*] reported overall and disease-free survival rates at 5 years in patients with stage II disease of 84.9 and 84.9 % in the open group and 93.7 and 90 % in the LR group, respectively; while in patients with stage III disease, these rates were 63.4 and 54.6 % in the open group and 66.7 and 56.9 % in the LR group, respectively [*13*].

Conclusions

This study and the literature confirm that laparoscopy for transverse colon cancer is feasible and safe, with similar early short-term outcomes when compared to open surgery. Larger prospective comparative studies with long-term follow-up are needed to assess the oncological equivalence of these two approaches.

References

1.

Fowler DL, White A (1991) Laparoscopy-assisted sigmoid resection. Surg Laparosc Endosc 1:183–188

2.

Jacobs M, Verdeja JC, Goldstein HS (1991) Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1:144–150

3.

Cooperman AM, Katz V, Zimmon D, Botero G (1991) Laparoscopic colon resection: a case report. J Laparoendosc Surg 1:221–224

4.

Schwenk W, Haase O, Neudecker JJ, Müller JM (2005) Short term benefits for laparoscopic colorectal resection. Cochrane Database Syst Rev Issue 2. Art. No.: CD003145. doi: 10.1002/14651858.CD003145.pub2

5.

Kuhry E, Schwenk W, Gaupset R, Romild U, Bonjer HJ (2008) Long term results of laparoscopic colorectal cancer resection. Cochrane Database Syst Rev Issue 2. Art. No.: CD003432. doi: 10.1002/14651858.CD003432.pub2

6.

Simorov A, Shaligram A, Shostrom V, Boilesen E, Thompson J, Oleynikov D (2012) Laparoscopic colon resection trends in utilization and rate of conversion to open procedure. a national database review of academic medical centers. Ann Surg 256(3):462–468

7.

Zmora O, Bar-Dayan A, Khaikin M, Lebeydev A, Shabtai M, Ayalon A, Rosin D (2010) Laparoscopic colectomy for transverse colon carcinoma. Tech Coloproctol 14:25–30

8.

Lee YS, Lee IK, Kang WK, Cho HM, Park JK, Oh ST, Kim JG, Kim YH (2008) Surgical and pathological outcomes of laparoscopic surgery for transverse colon cancer. Int J Colorectal Dis 23:669–673

9.

Schlachta CM, Mamazza J, Poulin EC (2007) Are transverse colon cancers suitable for laparoscopic resection? Surg Endosc 21:396–399

10.

Kim HJ, Lee IK, Lee YS, Kang WK, Park JK, Oh ST, Kim JG, Kim YH (2009) A comparative study on the short-term clinicopathologic outcomes of laparoscopic surgery versus conventional open surgery for transverse colon cancer. Surg Endosc 23:1812–1817

11.

Akiyoshi T, Kuroyanagi H, Fujimoto Y, Konishi T, Ueno M, Oya M, Yamaguchi T (2010) Short-term outcomes of laparoscopic colectomy for transverse colon cancer. J Gastrointest Surg 14:818–823

12.

Nakashima M, Akiyoshi T, Ueno M, Fukunaga Y, Nagayama S, Fujimoto Y, Konishi T, Noaki R, Yamakawa K, Nagasue Y, Kuroyanagi H, Yamaguchi T (2011) Colon cancer in the splenic flexure: comparison of short-term outcomes of laparoscopic and open colectomy. Surg Laparosc Endosc Percutaneous Tech 21:415–418

13.

Yamamoto M, Okuda J, Tanaka K, Kondo K, Tanigawa N, Uchiyama K (2012) Clinical outcomes of laparoscopic surgery for advanced transverse and descending colon cancer: a single-center experience. Surg Endosc 26:1566–1572

14.

Fernández-Cebrián JM, Yonte PG, Jimenez-Toscano M, Vega L, Ochando F (2012) Laparoscopic colectomy for transverse colon carcinoma: a surgical challenge but oncologically feasible. Colorectal Dis 15:e79–e83

15.

Matsuda T, Fujita H, Kunimoto Y, Kimura T, Hayashi T, Maeda T, Yamakawa J, Mizumoto T, Ogino K (2013) Clinical outcomes of laparoscopic surgery for transverse and descending colon cancers in a community setting. Asian J Endosc Surg 6(3):186–191

16.

Hahn K-Y, Baek S-J, Joh Y-G, Kim S-H (2012) Laparoscopic resection of transverse colon cancer: long-term oncologic outcomes in 58 patients. J Laparoendosc Adv Surg Tech A 22(6):561–566

17.

Lacy AM, Garcia-Valdecasas JC, Delgado S, Castells A, Taura P, Pique JM, Visa J (2002) Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomized trial. Lancet 359:2224–2229

18.

Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, Heath RM, Brown JM (2005) Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASSIC trial): multicentre, randomized controlled trial. Lancet 365:1718–1726

19.

Clinical Outcomes of Surgical Therapy Study Group (2004) A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 350:2050–2059

20.

Veldkamp R, Kuhry E, Hop WC, Jeekel J, Kazemier G, Bonjer HJ, Haglind E, Pahlman L, Cuesta MA, Msika S, Morino M, Lacy AM (2005) Colon cancer laparoscopic or open resection study group (COLOR). laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomized trial. Lancet Oncol 6:477–684

21.

Fleshman J, Sargent DJ, Green E, Anvari M, Stryker SJ, Beart RW Jr, Hellinger M, Flanagan R Jr, Peters W, Nelson H (2007) Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST study group trial. Ann Surg 246:655–662 discussion 662-664

22.

Lohsiriwat V, Lohsiriwat D, Chinswangwatanakul V, Akaraviputh T, Lert-Akyamanee N (2007) Comparison of short-term outcomes between laparoscopically-assisted versus transverse incision open right hemicolectomy for right-sided colon cancer: a retrospective study. World J Surg Oncol 5:49–53

23.

Yamamoto M, Okuda J, Tanaka K, Kondo K, Asai K, Kayano H, Masubuchi S, Uchiyama K (2013) Effect of previous abdominal surgery on outcomes following laparoscopic colorectal surgery. Dis Colon Rectum 56:336–342

24.

Lu KC, Cone MM, Diggs BS, Rea JD, Herzig DO (2011) Laparoscopic converted to open colectomy: predictors and outcomes from the national inpatient sample. Am J Surg 201:634–639