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Original Article

Laparoscopic colectomy for transverse colon cancer: comparative analysis of short- and long-term outcomes

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Abstract: This study evaluated the short- and long-term outcomes of laparoscopic colectomy compared with open colectomy for patients with transverse colon cancer by matched-pair analysis. This study enrolled 59 patients who underwent laparoscopic colectomy and compared them with 59 matched patients who underwent open colectomy for transverse colon cancer. The following parameters were matched: clinical stage and type of resection. Both short- and long-term outcomes of laparoscopic colectomy were compared with those of open colectomy. No difference was observed between the two groups in terms of age, gender, ASA score, comorbidity, clinical stage and operative procedures. Regarding short-term outcomes, blood loss, time to first flatus, time to liquid diet and postoperative stay were significantly shorter in the laparoscopy group than in the open group, while operation time was significantly longer in the laparoscopy group than in the open group. Postoperative complication was similar between the two groups. With respect to long-term outcomes, the two groups did not differ significantly in terms of 5-year overall and disease-free survival. In summary, laparoscopic colectomy is a safe and feasible option for selected patients with transverse colon cancer. The short- and long-term outcomes of laparoscopic colectomy are considered to be acceptable.

Keywords: Laparoscopy, minimally invasive surgery, colectomy, transverse colon cancer, long-term outcomes

Introduction

Since the first laparoscopic colectomy was reported in 1991, laparoscopic colectomy has become a realizable option for patients with colon cancer. With regard to the advantages of laparoscopic colectomy, some prospective randomized controlled trials have shown that the short-term outcomes for patients who underwent laparoscopic colectomy were better than for those who underwent an open colectomy and long-term outcomes were similar between laparoscopic colectomy and open resection [1-4]. As a result, the number of laparoscopic colectomies performed worldwide has increased recently [5-8]. However, these randomized controlled trials excluded transverse colon cancer due to low incidence and technically demanding [1-4]. But the feasibility of laparoscopic colectomy for transverse colon cancer also should be guaranteed oncologically. Therefore, in this study, we evaluated the short- and long-term outcomes of laparoscopic colectomy compared with those of open colectomy for patients with transverse colon cancer by matched-pair analysis.

Materials and methods

Patients

This study complied with the Declaration of Helsinki. This retrospective research was approved by the Ethics Committee of Zhongshan Hospital, Fudan University. The need for informed consent from all patients was waived because of retrospective study, not prospective trial.

Between January 2006 and January 2014, this study enrolled 59 patients with operable transverse colon cancer who underwent laparoscopic colectomy. These patients were compared with a consecutive group of 59 patients matched by clinical stage and type of resection who underwent open resection during the same period. Both the short-term outcomes and long-term outcomes for the patients who underwent laparoscopic colectomy were compared with

Table 1. Baseline characteristics

	Laparoscopy (*n*=59)	Open (*n*=59)	*P* value
Age (y)	60 (41-75)	61 (43-72)	0.683
Gender (Male: Female)	34: 25	32: 27	0.711
Comorbidity			0.976
Hypertension	3	2	
Diabetes Mellitus	9	6	
Coronary heart disease	2	1	
Clinical stage (cTNM)			0.732
I	18	19	
II	20	21	
III	21	19	
ASA score			0857
I	36	37	
II	21	20	
III	2	2	
Surgical procedure			0.848
Transverse colectomy	17	18	
Extended right hemicolectomy	26	23	
Extended left hemicolectomy	16	18	

Laparoscopy: laparoscopic colectomy; Open: open colectomy.

Table 2. Surgical Outcomes

	Laparoscopy (*n*=59)	Open (*n*=59)	*P* value
Operative time (min)	180.0 (160-220)	140.0 (130-190)	0.000
Blood loss (ml)	130.0 (100-180)	200.0 (170-250)	0.000
Time to first flatus (d)	3 (2-6)	4 (3-8)	0.000
Time to liquid diet (d)	5 (3-9)	6 (5-9)	0.000
Postoperative stay (d)	11 (9-21)	13 (8-26)	0.020
Postoperative complications	7	14	0.092
Severity of complications			
Major (3b, 4a, 4b and 5)	1	2	
Anastomotic leakage	1	1	
Heart failure	0	1	
Minor (1, 2 and 3a)	6	12	
Wound infection	1	3	
Atelectasis	1	3	
Pancreatitis	2	4	
Chylous ascites	1	1	
Ileus	1	1	

Laparoscopy: laparoscopic colectomy; Open: open colectomy.

those for the patients who underwent open colectomy.

Short-term data and long-term data were obtained from medical records and follow up databases. Post-operative complications, morbidity occurring within 30 postoperative days or hospital stay, were graded according to the Clavien-Dindo classification [9, 10]. Major complications were defined as grades 3b, 4a, 4b and 5. Minor complications were classified as 1, 2 and 3a. Operative death was defined as mortality within 30 days or hospital stay after resection. During the first year after colectomy was completed, patients were seen every 3 months at the outpatient department. In the second year, follow-up took place every 6 months, and then follow-up was performed at the end of each year after treatment. During each follow-up, serum CEA (carcinoembryonic antigen), CA-19-9, chest and abdominopelivc CT were performed. Colonoscopy was performed yearly. Disease recurrence was defined as locoregional or distant metastasis proven by radiology or pathology when availably [11-15]. The last follow up was November 2014.

Indications

Inclusion criteria of laparoscopic colectomy for transverse colon cancer in our institution were as follows: histologically confirmed carcinoma of the transverse colon, performance status of ECOG 0-1, no evidence of distant metastasis or invasion to adjacent organs, and clinical stage of cT1-3N0-1M0; all resections were performed with radical intent. Exclusion criteria included a colectomy under emergency and patients submitted to palliative resection.

All patients underwent colonoscopy, magnetic resonance imaging of brain, chest and abdominopelivc CT, and ultrasonography of liver to determine the clinical stage and to exclude clinical metastasis. Positron emission tomography-computerized tomography (PET-CT) and preoperative colonscopic India ink tattooing

Table 3. Pathological data

	Laparoscopy (*n*=59)	Open (*n*=59)	*P* value
Histologic differentiation			0.706
Well	26	28	
Moderately	19	17	
Poorly	11	13	
Mucinous	3	1	
Retrieved lymph nodes	14 (13-23)	15 (14-22)	0.350
Pathological stage (pTNM)			0.571
I	6	7	
II	26	28	
III	27	24	
Residual tumor			1.000
R0	53	53	
R1	0	0	
R2	0	0	

Laparoscopy: laparoscopic colectomy; Open: open colectomy.

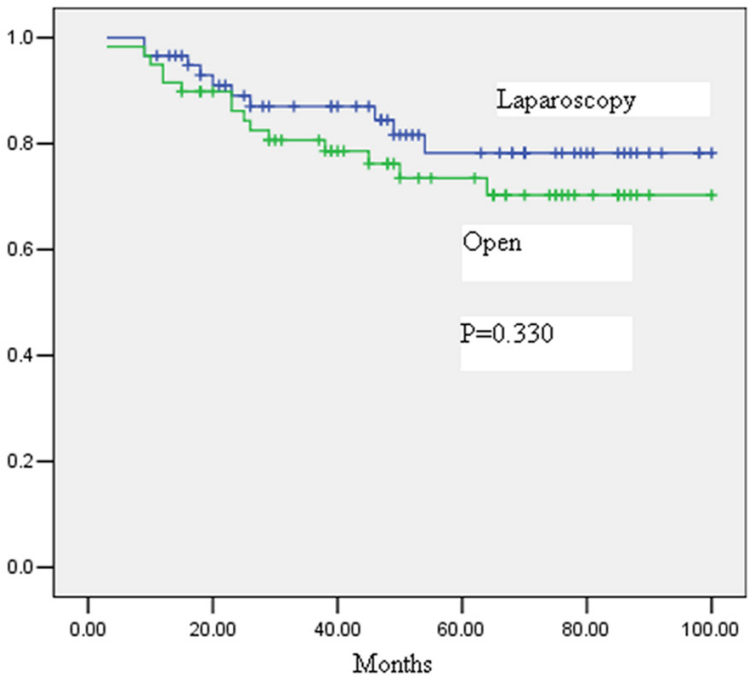

Figure 1. Comparison of overall survival rate between laparoscopy group and open group. There was no significant difference between the 2 groups (*P* = 0.330).

and clipping were performed in selected cases when necessary.

The clinical TNM stage of transverse colon cancer was based on the 7th edition of the TNM classification of colorectal cancer which was proposed by International Union against Cancer (UICC) and American Joint Committee on Cancer (AJCC) [16, 17]. For those of the patients operated before 2010, their staging was recalculated to match the latest TNM classification.

Operative technique

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 extended left hemicolectomy. Transverse colectomy was performed for tumor located centrally in the transverse colon. For lymphadenectomy, D2 lymphadenectomy was performed for cases up to cT1-2N0M0 and D3 lymphadenectomy was performed for cases of T3 and N1. A detailed procedure of colectomy for transverse colon cancer has been described elsewhere [18].

Statistical analysis

Variables were presented as mean and standard deviations for variables following normal distribution and were analyzed by *t* test. For variables following non-normal distribution, data were expressed as median and range and were compared by nonparametric test. Differences of semiquantitative results were analyzed by Mann-Whitney *U*-test. Differences of qualitative results were analyzed by chi-square tests or Fisher exact test. Survival rates were analyzed using the Kaplan-Meier method; differences between the two groups were analyzed with the log-rank test. The overall survival was assessed from the date of colectomy until the last follow up or death of any cause. The disease-free survival was calculated from the date of colectomy until the date of disease recurrence or death of any cause. Prognostic factors for overall survival

Table 4. Tumor recurrence data

Outcomes	Laparoscopy	Open	*P*
Tumor recurrence *n* (%)	6 (10.2)	9 (15.3)	0.407
Recurrence site			
Local	4	5	
Systemic	2	4	
Liver	1	2	
Lung	1	1	
Duodenum	0	1	
Time to recurrence (median)	19	17	0.523

Laparoscopy: laparoscopic colectomy; Open: open colectomy.

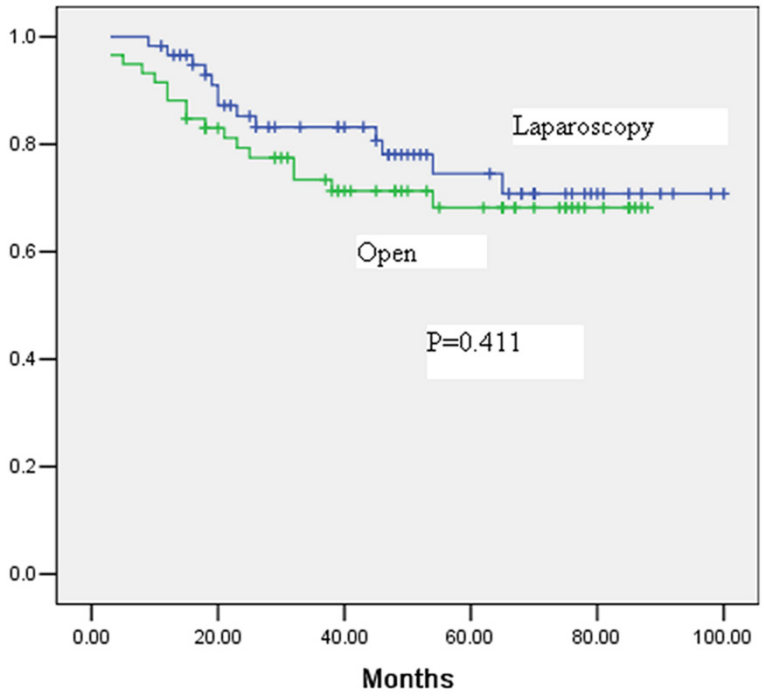

Figure 2. Kaplan-Meier disease-free survival curves of the laparoscopy group and the open group. No significant difference was observed (*P* = 0.411).

Table 5. Prognostic factors for overall survival

Factors	Univariate *P* value	Multivariate *P* value
Age	0.032	
Sex	0.302	
Operation time	0.075	
Tumor size	0.018	
Histological subtype	0.079	
Pathological T state	0.006	0.005
Pathological N stage	0.002	0.003
Adjuvant therapy	0.302	

and disease-free survival were analyzed with the Cox regression model. All statistical tests were two-sided, with the threshold of significance set at $P < 0.05$ level. Analysis was performed using SPSS 19.0 (SPSS Inc., an IBM company, Chicago, IL, USA).

Results

Baseline characteristics

Table 1 summarizes the baseline characteristics of the two groups. No difference was observed between the two groups in age, gender, ASA score, comorbidity, clinical stage and operative procedures.

Surgical outcomes

The surgical outcomes of both cohorts were summarized in **Table 2**. The operative time for laparoscopic colectomy was significantly longer than that after open colectomy ($P = 0.000$). The blood loss ($P = 0.000$), time to first flatus ($P = 0.000$), time to liquid diet ($P = 0.000$) and postoperative stay ($P = 0.020$) after laparoscopic surgery were significantly shorter than that after open colectomy, which presented the advantage of minimally invasive colectomy. There were no hospital stay or 30-day death occurred in this cohort. The incidence of postoperative complications tended to be lower among the laparoscopic colectomy patients than among the open colectomy patients, although the difference did not reach statistical significance ($P = 0.092$).

The pathological data were presented in **Table 3**. Pathological analysis was performed by a pathologist specialized in colorectal disease.

Table 6. Literature review of long-term outcomes by laparoscopic surgery versusopen resection for transverse colon cancer

Study	Number of Patients	Approach	Overall survival	Disease-free survival
Zhao L [18] (2014, China)	157	LAR 74	5-year: 73.6%	5-year: 70.5%
		Open 83	5-year: 71.1%	5-year: 66.7%
Mistrangelo M [19] (2014, Italy)	149	LAR 66	5-year: 86.4%	5-year: 80.4%
		Open 57	5-year: 88.6%	5-year: 77.3%
Kim WR [20] (2014, Korea)	131	LAR 84	5-year: 94.3%	5-year: 87.4%
		Open 47	5-year: 86.7%	5-year: 85.7%
Present study (2015, China)	118	LAR 59	5-year: 78%	5-year: 76%
		Open 59	5-year: 75%	5-year: 71%

LAR: laparoscopic colectomy; Open: open colectomy.

For pathological data, there were no significant differences between the two groups with respect to histologic differentiation, excised lymph nodes, surgical margins and pathological TNM stage (7th AJCC-UICC) (**Table 3**).

Long-term outcomes

There was no significant difference in median follow up period between the two groups. With regard to long-term outcomes, the overall survival rates for the laparoscopy group were 85% at 3 years, and 78% at 5 years. By comparison, the overall survival rates for the open group were 79% at 3 years, and 75% at 5 years (**Figure 1**).

Recurrent tumors developed in 10.2% of the patients in laparoscopy group and in 15.3% of the patients in open group. There were no significant differences with respect to the sties of recurrence (**Table 4**). No patient occurred portside metastasis. The postoperative disease-free survival rates for the laparoscopy group were 82% at 3 years and 76% at 5 years. The corresponding rates for the open group were 75% at 3 years, and 71% at 5 years (**Figure 2**). The two groups did not differ significantly in terms of overall (P = 0.330) and disease-free survival (P = 0.411).

In regard to prognostic factors for overall survival, age, tumor size, pathological T state and pathological N stage were prognostic factors in univariate analysis. In multivariate analysis, pathological T state and pathological N stage were independent prognostic factors for overall survival (**Table 5**).

The overall survival and disease-free survival of our series were comparable to the results available in the literature (**Table 6**).

Discussion

The current study investigated the short- and long-term outcomes of laparoscopic colectomy compared with open colectomy for patients with transverse colon cancer by matched-pair analysis. In terms of short-term outcomes, we found that the blood loss, time to first flatus, time to liquid diet and postoperative stay with laparoscopic colectomy was significantly shorter than with open colectomy. Regarding long-term outcomes, there were no significant differences in overall or disease-free survival between the laparoscopic and open groups.

Previous studies have indicated that the short-term outcomes with laparoscopic colectomy for transverse colon cancer were better than with open colectomy [18-25]. The results of these reports above mentioned are consistent with our data. However, the median postoperative hospital stay after laparoscopic colectomy in our study was 11 days, which was markedly longer than in other reports [22-26]. This phenomenon may be explained by the difference in the insurance system. Because the same insurance system applied for both laparoscopic colectomy and open colectomy, our findings of a postoperative shorter hospital stay with laparoscopic resection might be clinically meaningful.

There were several studies of comparable results about long-term outcomes of laparoscopic colectomy versus open resection of transverse colon cancer so far [18-22]. In our study, long-term outcome of were also similar in the two groups. The 3- and 5-year overall survival rate for laparoscopic colectomy versus open resection was 85% versus 79%, and 78% versus 75%, respectively (P = 0.330). The 3- and 5-year disease-free survival rate for laparoscopic resection versus open colectomy was 82 versus 75%, and 76% versus 71%, respec-

tively (P = 0.411). The reported 5-year overall survival after laparoscopic resection for transverse colon cancer ranged from 73.6% to 94.3%, and the 5-year disease-free survival ranged from 70.5% to 87.4% [18-22]. In the present study, 5-year overall and disease-free survival of LR was 92.2 and 54.0%, respectively, and the long-term outcomes of our study were similar with other reports. These excellent results in our study may be partially due to highly selected and good candidates for laparoscopic colectomy.

In the present study, there were some limitations. Above all, this is a retrospective study from a single institution. The findings of this study may be limited to the retrospective nature of the analysis. Therefore, we cannot certainly guarantee that there was no possibility of selection bias. The surgeons perhaps tended to select laparoscopic colectomy only in relatively simple and easy case for laparoscopic approach. Additionally, the total number of patients was relatively small in both groups (59 patients in each).

Nevertheless, we believe that the present study could serve as useful background research for future randomized clinical trials on laparoscopic colectomy for transverse colon cancer. We expect to investigate further studies such as well-designed, large, observational studies or randomized clinical trials as we accumulate experience and cases of laparoscopic colectomy for transverse colon cancer.

In conclusion, the present study showed that the outcome of laparoscopic colectomy for transverse colon cancer was technically feasible and safe in selected patients. Laparoscopic colectomy showed similar long-term oncologic outcomes when compared with open resection based on matched-pair analysis. However, laparoscopic colectomy for transverse colon cancer should be performed for carefully selected patients and by an expert surgical team. In addition, further well-designed, large scale, comparative studies and randomized controlled clinical trials should be continued in this field.

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Disclosure of conflict of interest

None.

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