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Comparative study of oncologic outcomes for laparoscopic *vs*. open surgery in transverse colon cancer

Woo Ram Kim, Se Jin Baek, Chang Woo Kim, Hyun A Jang, Min Soo Cho, Sung Uk Bae, Hyuk Hur, Byung Soh Min, Seung Hyuk Baik, Kang Young Lee, Nam Kyu Kim, Seung Kuk Sohn

Section of Colon and Rectal Surgery, Department of Surgery, Yonsei University College of Medicine, Seoul, Korea

Purpose: Laparoscopic resection for transverse colon cancer is a technically challenging procedure that has been excluded from various large randomized controlled trials of which the long-term outcomes still need to be verified. The purpose of this study was to evaluate long-term oncologic outcomes for transverse colon cancer patients undergoing laparoscopic colectomy (LAC) or open colectomy (OC).
Methods: This retrospective review included patients with transverse colon cancer who received a colectomy between January 2006 and December 2010. Short-term and five-year oncologic outcomes were compared between these groups.
Results: A total of 131 patients were analyzed in the final study (LAC, 84 patients; OC, 47 patients). There were no significant differences in age, gender, body mass index, tumor location, operative procedure, or blood loss between groups, but the mean operative time in LAC was significantly longer (LAC, 246.8 minutes vs. OC, 213.8 minutes; P = 0.03). Hospital stay was much shorter for LAC than OC (9.1 days vs. 14.5 days, P < 0.01). Postoperative complication rates were not statistically different between the two groups. In terms of long-term oncologic data, the 5-year disease-free survival and overall survival were not statistically different between both groups, and subgroup analysis according to cancer stage also revealed no differences.
Conclusion: LAC for transverse colon cancer is feasible and safe with comparable short- and long-term outcomes.
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Key Words: Laparoscopic surgery, Colonic neoplasm, Colon, Transverse

INTRODUCTION

Laparoscopic colon surgery (LAC) was first introduced for the treatment of colorectal cancer in 1991 [1]. Since its introduction, there have been many technical improvements to this procedure. Several randomized controlled trials have demonstrated its safety, oncologic efficacy and short-term benefits including shorter hospital stays, less postoperative pain and earlier return to normal activity compared to an open colectomy (OC) [2-11].

Given the technical difficulty involved in performing complete mesocolic excision and ligation of the middle colic vessels by laparoscopy, many of these trials have not included patients with transverse colon cancer [12,13]. Recently, several experienced surgeons have started to report on the oncologic outcomes for laparoscopic colectomy in patients with transverse colon cancer [11,14-16], but long-term outcomes still need to be verified.

As a tertiary referral care center, our institution has many experiences with laparoscopic surgery for transverse colon cancer. This study investigated the oncologic outcomes for laparoscopic surgery compared to open surgery in patients with transverse colon cancer in our institution.

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Corresponding Author: Seung Hyuk Baik
Section of Colon and Rectal Surgery, Department of Surgery, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Korea.
Tel: +82-2-2228-2100, **Fax:** +82-2-313-8289
E-mail: whitenoja@yuhs.ac

METHODS

This retrospective study included 141 consecutive patients who underwent a curative colectomy for transverse colon cancer (pathologic TNM stage I–III) at the Yonsei University Health System between January 2006 and December 2010. Then 10 patients were excluded due to a previous malignancy, double primary cancer and missing follow-up (Fig. 1).

Diagnosis of colon cancer was confirmed by a colonoscopic biopsy. For evaluation of distant metastasis, an abdominopelvic and a chest computed tomography (CT) were performed. If necessary, a positron emission tomography (PET)-CT and liver magnetic resonance imaging (MRI) were also performed. Any tumor distal to the hepatic flexure and proximal to the splenic flexure was defined as transverse colon cancer.

Tumor staging was based on the 7th American Joint Committee on Cancer guidelines.

The decision to perform a laparoscopic colectomy versus an OC was at the surgeon's discretion. In cases of early transverse colon cancer detection, unless the tumor was greater than T3 or proved to be bulky on the CT scan, colonoscopic tattooing was performed preoperatively for easier intraoperative localization. For primary lesions distal to the hepatic flexure, an extended right hemicolectomy was performed by ligation of the ileocolic, the midcolic and the right colic vessels (if present). Lesions proximal to the splenic flexure underwent an extended left hemicolectomy with ligation of the midcolic, left colic and the first branch of the sigmoid vessels. Transverse colectomy was performed by ligation of the midcolic vessels when the remaining transverse colon was free enough of tension to be anastomosed. Subtotal colectomy was also performed if it was necessary. We utilized a medial to lateral no-touch isolation technique, which enabled dissection of lymph nodes along the surgical trunk, followed by transection of the colon and mesentery without tumor manipulation. This degree of resection was similar to the technique used in Hohenberger et al. [17]. Methods for anastomosis were determined based

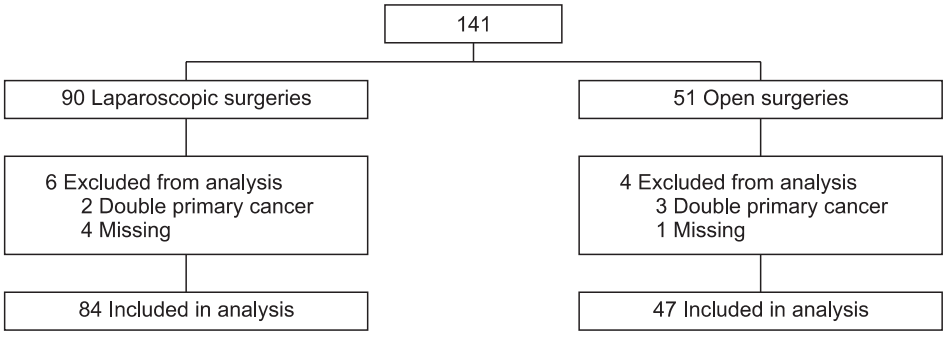

Fig. 1. Overall study design and overview of patient population.

Table 1. Clinical characteristics and surgical data in the laparoscopic and conventional open surgery groups

Characteristic	LAC (n = 84)	OC (n = 47)	P-value
Age (yr)	62.3 ± 11.6	59.7 ± 13.2	0.24
Sex (male:female)	45:39	27:20	0.67
Body mass index (kg/m^2)	23.6 ± 3.7	22.5 ± 3.3	0.12
Location of tumor			0.17
Hepatic flexure	56 (66.7)	24 (51.1)	
Mid transverse	12 (14.3)	12 (25.5)	
Splenic flexure	16 (19.0)	11 (23.4)	
Operation			0.09
Extended right colectomy	57 (67.9)	24 (51.0)	
Transverse colectomy	11 (13.1)	10 (21.3)	
Extended left colectomy	16 (19.0)	11 (23.4)	
Subtotal colectomy	0 (0)	2 (4.3)	
Operation time (min)	246.8 ± 85.6	213.8 ± 72.8	0.03
Blood loss (mL)	125.8 ± 224.5	130.0 ± 161.6	0.91
Conversion to open	2 (2.4)	-	-

Values are presented as mean ± standard deviation or number (%). An independent t-test for continuous values and chi-square test for categorical values.
LAC, laparoscopic colectomy; OC, open colectomy.

on surgical preference and performed extracorporially in laparoscopic colectomy cases in a manner similar to the open procedure.

Clinical characteristics, short-term surgical outcomes and midterm oncologic outcomes were compared between the laparoscopic and open surgery groups. Postoperative

Table 2. Tumor characteristics in the laparoscopic and conventional open surgery groups

Characteristic	LAC (n = 84)	OC (n = 47)	P-value
Tumor size (cm)	4.6 ± 2.7	5.0 ± 2.5	0.37
Grade of differentiation			0.34
Well	19 (22.6)	8 (17.1)	
Moderately	54 (64.3)	34 (72.3)	
Poorly	7 (8.3)	1 (2.1)	
Others	4 (4.8)	4 (8.5)	
PRM (cm)	20.7 ± 13.7	22.7 ± 15.1	0.45
DRM (cm)	10.9 ± 10.5	12.8 ± 10.3	0.31
No. of retrieved lymph nodes	27.4 ± 21.7	28.0 ± 19.8	0.88
pTNM stage			0.01
Tis / I	28 (33.3)	6 (12.7)	
II	37 (44.0)	21 (44.7)	
III	19 (22.6)	20 (42.6)	

Values are presented as mean ± standard deviation or number (%). An independent t-test for continuous values and chi-square test for categorical values.
LAC, laparoscopic colectomy; OC, open colectomy; PRM, proximal resection margin; DRM, distal resection margin.

Table 3. Postoperative short-term outcomes in the laparoscopic and conventional open surgery groups

Characteristic	LAC (n = 84)	OC (n = 47)	P-value
Hospital stay (day)	9.1 ± 4.4	14.5 ± 7.5	<0.01
Morbidity			0.16
Minor complication, n (%)	7 (8.4)	6 (12.8)	
Grade I			
Wound seroma	4	0	
Atelectasis	1	0	
Grade II			
Ileus or obstruction	0	2	
Minor bleeding	2	1	
Chylous ascites	0	2	
Pancreatitis	0	1	
Major complication, n (%)	1 (1.2)	2 (4.3)	
Grade III			
Anastomotic leakage	1	2	
Grade IV	0	0	
Grade V	0	0	
Recurrence site			-
Local	2	0	
Systemic	7	6	
Liver	4	3	
Lung	2	3	
Stomach	1	0	
Duodenum	1	1	
Peritoneal seeding	3	1	

Values are presented as mean ± standard deviation or number (%). An independent t-test for continuous values and chi-square test for categorical values.
LAC, laparoscopic colectomy; OC, open colectomy.

complications were classified as grades I–V according to the Dindo classification scale, which were further subdivided into minor (stages I–II) and major (stages III–V) complications [18]. We routinely examined patients in the outpatient clinic at 1 and 3 months postdischarge, then every 3 months for the first three years and finally every 6 months for the subsequent 2 years. Carcinoembryonic antigen was performed prior to surgery, at postoperative day 7 and whenever the patient had postoperative follow-up in the outpatient clinic. For diagnosis of local and systemic recurrence, an abdominopelvic CT and a chest CT were performed at every 6 months during the follow-up period. A PET-CT and liver MRI were also performed if it was necessary.

Data were analyzed using the IBM SPSS ver. 18.0 (IBM Co., Armonk, NY, USA). An independent t-test for continuous values and Fisher exact test for parametric values were performed. Categorical variables were compared using the chi-square test (Tables 1-3). We constructed survival curves using the Kaplan-Meier method (Figs. 2, 3) and comparisons were made using the log-rank test. A P-value less than 0.05 was considered statistically significant.

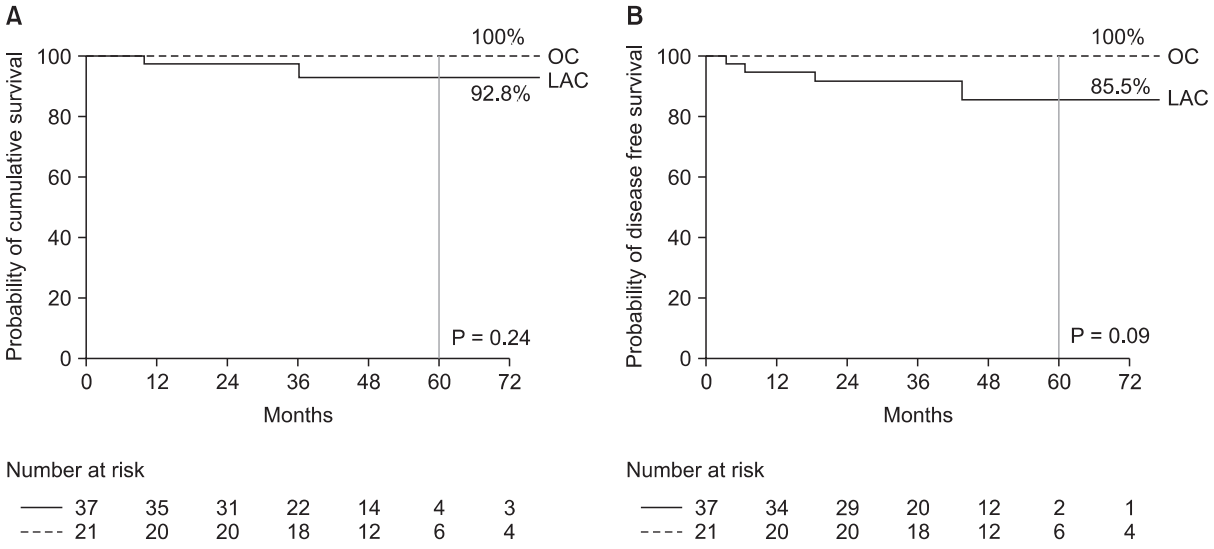

Fig. 2. Kaplan-Meier estimates of overall survival (A) and disease free survival (B) in the laparoscopic and conventional open group for stage II transverse colon cancer. OC, open colectomy; LAC, laparoscopic colectomy.

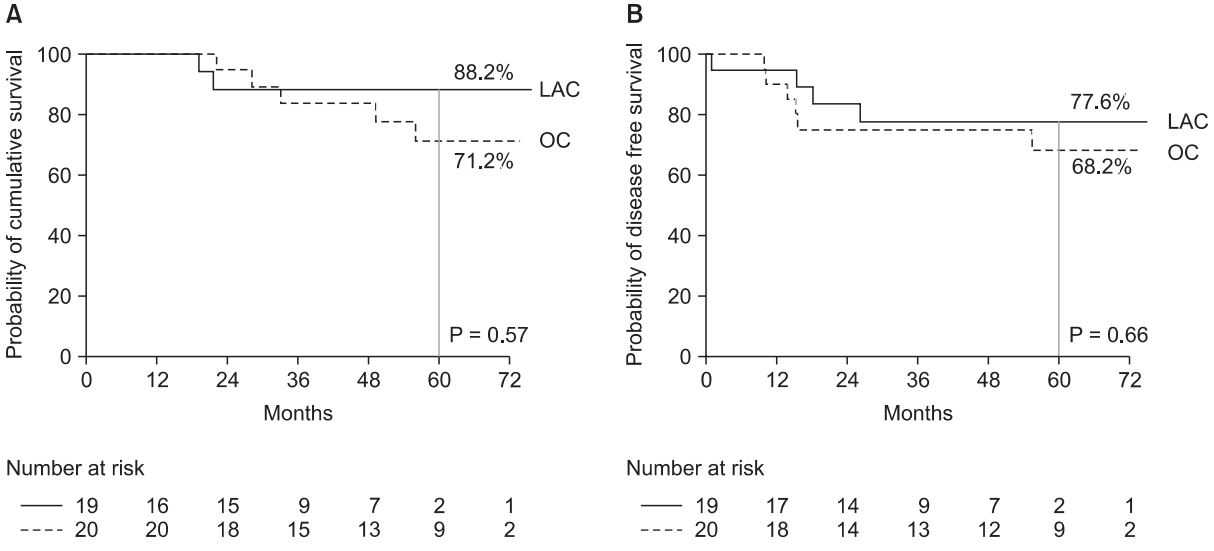

Fig. 3. Kaplan-Meier estimates of overall survival (A) and disease free survival (B) in the laparoscopic and conventional open group for stage III transverse colon cancer. LAC, laparoscopic colectomy; OC, open colectomy.

RESULTS

A total of 131 patients were analyzed in the final study (LAC, 84 patients; OC, 47 patients). Patient demographics and operative data are presented in Table 1. There was no difference in sex, age, body mass index, tumor location, operative procedure or blood loss between the groups, but the mean operative time in LAC was significantly longer (LAC, 246.8 minutes *vs.* OC, 213.8 minutes; P = 0.03). Two cases (2.4%) were converted to open surgery due to the presence of severe adhesions.

There were no significant differences in tumor size, histology type between the two groups (Table 2). No intergroup differences in proximal margin, distal margin and number of harvested lymph nodes were also observed. According to the TNM classification system, early stage transverse colon cancer (Tis, stage I) was observed more frequently in the LAC group compared to the OC group (33.3% *vs.* 12.7%), whereas stage III disease was more prevalent in the OC group than the LAC group (42.6% *vs.* 22.6%) (P = 0.01).

Hospital stay was considerably shorter for LAC than for OC (9.1 days *vs.* 14.5 days, P < 0.01) (Table 3). Rates of postoperative complications were not statistically different between the two groups (OC, 17.1% *vs.* LAC, 9.6%, P = 0.16). Most complications were minor including wound seroma, postoperative ileus or obstruction, minor bleeding and chylous ascites. Regarding major complications, two cases of grade 3 complications included major anastomotic leakages in the OC group, which required mandatory reoperations. One case of a grade 3 complication included a minor anastomotic leakage in the LAC group requiring only supportive care. There were no cases of immediate postoperative mortality in the two groups.

Median follow-up was 58 months (range, 10–85 months) for OC and 42 months (range, 7–82 months) for LAC. Nine patients (10.7%) had cancer recurrence in the LAC group during the follow-up period. Four patients died from systemic recurrence and cancer progression. In the OC group, 6 patients (12.8%) had cancer recurrences. Five of them had systemic recurrence and died from cancer progression. Five-year disease free survival (DFS) was 87.4% for LAC and 85.7% for OC, with no statistically significant difference between the two groups (P = 0.89). There were no intergroup differences in the 5-year overall survival (OS) (LAC, 94.3% *vs.* OC, 86.7%, P = 0.40).

We performed a subgroup analysis to evaluate any group differences attributable to the discrepancy of the cancer stage. According to our data, it was statistically impossible to compare DFS and OS in stage I patients between the two groups because there were no recurrence or disease-related death except only one recurrence in the LAC group. According to a subgroup analysis of stage II and III transverse colon cancer patients, there were no significant differences in OS and DFS between the two groups (Figs. 2, 3). The results demonstrated that there were no statistically significant differences in 5-year DFS for stage II patients (LAC, 85.5% *vs.* OC, 100%, P = 0.09). In terms of 5-year OS, there were no statistical differences between the two groups (LAC, 92.8% *vs.* OC, 100%, P = 0.24). Similarly, there were no differences in 5-year DFS for stage III patients between both groups (LAC, 77.6% *vs.* OC, 68.2%, P = 0.66). 5-year OS in stage III patients were similar between two groups (LAC, 88.2% *vs.* OC, 71.2%, P = 0.57).

DISCUSSION

Laparoscopic approaches have been proposed in several surgical fields, and these modalities provide widely-recognized clinical benefits, including less pain and intraoperative blood loss, shorter recovery and hospitalization times, and better cosmetics. Laparoscopic colectomy has been shown not only to be technically safe and feasible, but also offers similar long-term outcomes for colorectal cancer compared to open surgical procedures based on large, randomized controlled trials [4-8]. However, all these studies have excluded transverse colon cancer due to the technical difficulty in performing an adequate oncologic resection laparoscopically, and very few studies are available for laparoscopic colectomy of the transverse colon cancer.

In our results, LAC for transverse colon cancer was found to be quite safe and feasible. The rates of postoperative complications were not statistically different between the LAC and OC groups (OC, 17.1% *vs.* LAC, 9.6%, P = 0.16). These similar rates are comparable with other reports. Akiyoshi et al. [19] and Kim et al. [20] also reported in their studies that short-term postoperative complications were acceptable in laparoscopic colectomy for transverse colon cancer.

Generally, oncologic feasibility can be assessed from three points of view. First of all, adequate oncologic resection should be evaluated. Secondly, the recurrence rate should be acceptable. Lastly, OS should not be influenced by the surgical methods. Recently, some studies have started to report oncologic outcomes for LAC in transverse colon cancer. Hahn et al. [15] reported acceptable oncologic outcomes compared to other previous randomized trials. The 5-year OS rate and disease-free survival rate was 84.7% and 89.3%, respectively in their study. However, the laparoscopic results were compared to results of other previous clinical trials instead of the results for open surgery results from the same period. On the other hand, our study showed acceptable oncologic outcomes of LAC for transverse colon cancer compared to OC during the follow-up observation.

In our study, 5-year DFS was 87.4% in LAC and 85.7% in OC (P = 0.89), whereas 5-year OS was 94.3% in LAC and 86.7% in OC (P = 0.40). These are also comparable oncologic results

to others. We suspect that these favorable oncologic results can be attributed to the surgical technique and planning. All laparoscopic colectomies in this study had complete mesocolic excision (CME) and central vascular ligation (CVL), first named by Hohenberger et al. [17] in 2008. There have been some debates of feasibility for CME-CVL in LAC. Gouvas et al. [21] insisted that laparoscopic CME-CVL surgery for transverse colon cancer was incomplete in comparison to open surgical resection in their study. However, Fujita et al. [22] described a medial approach to overcome this obstacle. They utilized a no-touch technique, which dissected lymph nodes along the surgical trunk, followed by transection of the transverse colon, terminal ileum, and mesentery without tumor manipulation. We also utilized this medial to lateral no-touch isolation technique. We also reported no significant differences in proximal resection margin (LAC, 20.7 cm *vs.* OC, 22.7 cm, P = 0.45), distal resection margin (LAC, 10.9 cm *vs.* OC, 12.8 cm, P = 0.31), and harvested lymph nodes (LAC, 27.4 *vs.* OC, 28.0, P = 0.88) between the LAC and OC groups. Therefore, we can confirm that laparoscopic transverse colectomy could be oncologically feasible for transverse colon cancer compared to open surgery.

This study does have some limitations. First, there was the selection bias often inherent in retrospective studies. The decision to undergo a laparoscopic colectomy was at the surgeon's discretion. Early stage transverse colon cancer (stages 0, I) more frequently proceeded to laparoscopic resection (LAC, 33.3% *vs.* OC, 12.7%). Meanwhile, advanced transverse colon cancer (stage III) was more frequently associated with open surgery (OC, 42.6% *vs.* LAC, 22.6%). For this reason, we performed a subgroup analysis for each stage, and similar results for the long-term follow-up between the two groups were also shown in the subgroup analysis. The second imitation is the small number of cases.

Based on the results of this study, laparoscopic colectomy for transverse colon cancer was feasible and safe with good short-term outcomes. Moreover, there were no significant differences in long-term oncologic outcomes between laparoscopy and open surgery. However, our conclusion cannot be generalized because of our study limitation. Nevertheless, we expect that our study may help lead to conduct future prospective randomized trials for investigation of long-term oncologic outcomes for laparoscopic colectomy in transverse colon cancer to confirm our study results.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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