Clinics in Surgery

Research Article
Published: 09 Jul, 2019

Intracorporeal Versus Extracorporeal Anastomosis in Laparoscopic Left Colectomy Forleft-Side Colon Cancer: A Retrospective Study

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Abstract

Background: Laparoscopic colectomy for colon cancer with Intracorporeal Anastomosis (IA) is a procedure that is being increasingly performed. The short-term outcomes of IA were compared with those of Extracorporeal Anastomosis (EA) in laparoscopic left colectomy for left-side colon cancer.

Methods: A series of 98 patients undergoing laparoscopic left colectomy for left-side colon cancer from May 2013 to November 2017 in our institution were retrospectively analyzed. Propensity score matching analysis was performed to overcome patient selection bias between the two surgical techniques.

Results: After propensity score matching, 20 patients in the IA group and 20 patients in the EA group were compared. There were no significant differences in operative time, estimated blood loss, complications, and postoperative course. The mini-laparotomy incision was significantly shorter in the IA than in the EA group (3.3 *vs*. 5.0 cm, $p < 0.01$). Although takedown of the splenic flexure to fully mobilize the left hemicolon was mandatory in the EA group, it was performed in only 5 patients (25.0%) in the IA group. Furthermore, the number of days to first flatus was shorter in the IA group than in the EA group (1 *vs*. 2 days, $p < 0.05$).

Conclusions: A totally laparoscopic colectomy with IA for the treatment of left-side colon cancer is technically feasible and can be performed with good cosmetic outcomes and decreased time to first flatus, suggesting faster recovery. Further investigations are needed to assess the oncological outcomes of this technique.

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Received Date: *22 May 2019*
Accepted Date: *28 Jun 2019*
Published Date: *09 Jul 2019*

Citation:
Masubuchi S, Okuda J, Hamamoto H, Ishii M, Osumi W, Yamamoto M, et al. Intracorporeal Versus Extracorporeal Anastomosis in Laparoscopic Left Colectomy Forleft-Side Colon Cancer: A Retrospective Study. Clin Surg. 2019; 4: 2506.

Introduction

The performance of laparoscopic surgery for colorectal cancer has increased dramatically since it was first reported in 1991 [1]. Clinical and scientific data show that laparoscopic colorectal surgery accelerates dietary intake and return of bowel function and reduces postoperative pain, the length of hospital stay, and the postoperative mortality rate [2-6]. Several meta-analyses and systematic reviews proved that laparoscopic colonic resection was safe, and oncological outcomes were similar after laparoscopic and open surgery for colorectal cancer [2,3,5,6].

Currently, in most institutions, laparoscopic-assisted colectomy with an Extracorporeal Anastomosis (EA) technique is the standard technique. However, the standard procedure for laparoscopic-assisted colectomy with EA includes requiring mobilization of the intestine and mesenteric traction to extract the intestine, theoretically leading to more surgical trauma [7,8]. Furthermore, this maneuver limits the location of the extraction site and could compromise bowel alignment after extraction [9]. Intracorporeal Anastomosis (IA) is an alternative approach that may alleviate some of the technical problems associated with EA. Several studies have recently compared the two techniques, laparoscopic right hemicolectomy with EA and totally laparoscopic right hemicolectomy with IA. Oncologic outcomes and anastomotic leak rates were equivalent for the two techniques. However, patients treated with IA had earlier return of bowel function, less pain, and a shorter hospital stay [7,9-12]. So far, there have been some comparative studies of laparoscopic right colectomy with EA and IA, but there were few comparative studies of laparoscopic left colectomy with EA and IA [13], because laparoscopic left colectomy is technically demanding [14]. The purpose of the present study was to compare these two techniques in the treatment of left-side colon cancer.

Material and Methods

A retrospective analysis of data of consecutive patients who underwent laparoscopic surgery for left-side colon cancer in our institution from May 2013 to December 2017 was performed. Left-side colon cancer was defined as a tumor located in the distal two-thirds of the descending colon or in the proximal sigmoid colon within 5 cm from the junction of the sigmoid colon and the descending colon. Overall, 98 patients were included, of whom 39 were treated by IA, and 42 were treated by EA; 17 patients were excluded due to anastomosis with double-stapling technique (Figure 1). All patients were fully informed of the study design according to the Ethics Committee on Clinical Investigation of Osaka Medical College Hospital (No.1029) and provided their written, informed consent to participate. The choice of operation, IA or EA, was determined by the operating surgeon. The standard procedures, such as skin preparation, antibiotic prophylaxis, surgical technique, and wound closure, were similar for all patients. Preoperatively, all patients received routine mechanical bowel preparation. In all cases, skin preparation involved preoperative full-body showering with non-antiseptic formulations and cleaning umbilical debris with an olive oil-soaked swab the day before surgery. Antibiotic prophylaxis was used in all patients. Cefmetazole sodium (1 g/dose) was given intravenously 30 min before surgery and at 3-h intervals thereafter. Antibiotics were administered only on the operative day.

Each patient was placed in the modified lithotomy position and given general anesthesia. Initial access to the peritoneal cavity was achieved with an open technique in a routine manner. A 12-mm first port was placed into the transumbilical minilaparotomy, followed by insufflations of 10 mmHg CO_2. The laparoscope was introduced to explore the entire abdomen. Other ports were placed in the right lower quadrant (12-mm port), right upper quadrant (5-mm port), left lower quadrant (5-mm port), and left upper quadrant (5-mm port). If necessary, a 5-mm port was added from the epigastrium. Lymphadenectomy was performed simultaneously with proximal ligation of tumor-feeding vessels, defined according to the Japanese Classification of Colorectal Carcinoma (usually left colic artery, sigmoid colic artery, left colic vein, and sigmoid colic vein). Widespread medial-to-lateral exploration of the retroperitoneum was performed for identification and protection of important structures (e.g., gonadal vessels and ureters). Tumor-specific mesorectal excision was performed as a standard surgical technique. Mobilization of the left hemicolon was mandatory, and, if necessary, the splenic flexure was taken down.

In the EA group, a mini-laparotomy incision was made over the transumbilical port site through which the bowel was externalized, after protecting the wound with the Alexis Wound Retractor® (Applied Medical Resources Corporation, Rancho Santa Margarita, CA, and USA). The colon was resected using a 60-mm linear staple. Extracorporeal anastomosis was performed by firing one 60-mm linear stapler load in an antiperistaltic side-to-side manner. The enterotomy was closed using one 60-mm linear stapler load.

In the IA group, the colon was resected intracorporeally using a 60-mm linear laparoscopic stapler. The resected specimen was placed anterior to the liver until the end of the laparoscopic parts of the operation, and thus it did not interrupt the working space. IA was performed by firing one 60-mm linear stapler load in an isoperistaltic side-to-side manner. The enterotomy was closed with the Albert-Lembert method, continuous suture using a 3-0 V-Loc® (Medtronic,

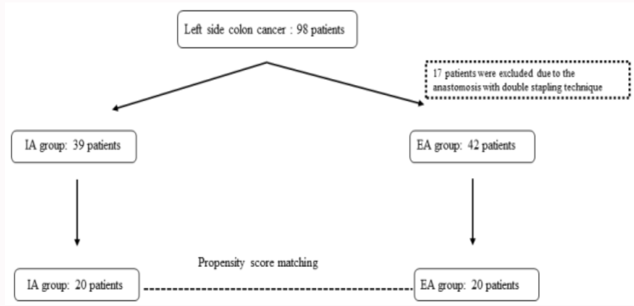

Figure 1: Flow chart of the study. A total of 98 patients underwent laparoscopic surgery for left side colon cancer. 17 patients were excluded due to anastomosis with double stapling technique. 39 patients underwent IA, and 42 patients underwent EA. Using propensity score matching, 20 of the 39 IA group patients were matched with 20 of the 42 EA group patients.

Minneapolis, MN, USA) and interrupted suture using 3-0 PDS® (Ethicon, Guaynabo, PR, USA). A mini-laparotomy incision was made over the transumbilical port site, the wound was protected with the Alexis Wound Retractor®, and it was used for specimen extraction. The defect between the mesentery and the mesocolon after colo-colic anastomosis was not closed in both groups. A drainage tube was not placed. For wound closure, the peritoneum and fascia were sutured together in an interrupted fashion using absorbable sutures. After the muscle layer was sutured, the subcutaneous tissue was washed with warm physiological saline solution and scrubbed with a disposable sponge. All cases were performed using interrupted transdermal and absorbable sutures. After skin closure, a hydrocolloid dressing was applied to the wound for 48 h. Subsequently, the wound was uncovered, and the presence of wound infection was evaluated according to the Guidelines of the Centers for Disease Control and Prevention [15]. Diets were initiated on the 3rd postoperative day.

Postoperative analgesia was maintained by continuous fentanyl infusion for 48 h. Intravenous infusion of flurbiprofen or oral administration of loxoprofen was used as an additional analgesic at the patient's request. Pain was assessed using the Visual Analogue Scale (VAS) and the number of additional analgesics from the operation day to the 3rd postoperative day.

Statistical analysis

To minimize the influence of potential confounders on section bias, propensity scores were generated using binary logistic regression included the following variables: gender, age, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) classification, medical history, TNM classification and maximum tumor diameter. One-to-one matching between groups was accomplished using the nearest-neighbor matching method, which was performed without replacement and using a caliper width of 0.2 standard deviations of the logit of the estimated propensity score. After propensity scores matching, the two matched groups were handled as unpaired independent groups. Statistical analysis was performed using JMP 12 for Windows (SAS Institute, INC., Cary, NC). Student's t-test and the chi-squared test were used to compare continuous and categorical variables, as appropriate, with a two-sided $p<0.05$ indicating significance.

Results

Patients

Patients included in this study were divided into the IA (n=39) and EA (n=42) groups. Using Propensity Score Matching (PSM), 20

Table 1: Characteristics of patients (n=81).

	IA group (N=39)	EA group (N=42)	*p* value
Before PSM			
Gender (male/female)	26:13:00	21:21	0.13
Age, years *	63 (29-85)	67.5 (29-88)	0.20
BMI *	23.4(18.2-42.8)	22.3 (17.5-27.8)	0.03
ASA classification (%)			0.03
Class 1	9 (23.1%)	22 (52.4%)	
Class 2	28 (71.8%)	19 (45.2%)	
Class 3	2 (5.1%)	1 (2.4%)	
Medical history (%)			0.69
Yes	7 (17.9%)	9 (21.4%)	
No	32 (82.1%)	33 (78.6%)	
Abdominal surgical history (%)			0.31
Yes	5 (12.8%)	9 (21.4%)	
No	34 (87.2%)	33 (78.6%)	
Depth of tumor invasion			0.21
Tis	2 (5.1%)	1 (2.4%)	
T1	12 (30.8%)	8 (19.0%)	
T2	5 (12.8%)	5 (11.9%)	
T3	16 (41.0%)	15 (35.7%)	
T4	4 (10.3%)	13 (31.0%)	
Lymph node metastasis			0.75
N0	29 (74.4%)	30 (71.4%)	
N1	8 (20.5%)	8 (19.0%)	
N2	2 (5.1%)	4 (9.5%)	
Distant metastasis			0.02
M0	38 (97.4%)	34 (81.0%)	
M1	1 (2.6%)	8 (19.0%)	
pTNM Stage			0.13
0	2 (5.1%)	1 (2.4%)	
I	15 (38.5%)	10 (23.8%)	
II	12 (30.8%)	15 (35.7%)	
III	9 (23.1%)	8 (19.0%)	
IV	1 (2.6%)	8 (19.0%)	
Maximum tumor diameter (cm) *	3.0 (0-8.7)	4.0 (0-7.9)	0.36
	N=20	N=20	
After PSM			
Gender (male/female)	11:09	14:06	0.33
Age, years *	68.5 (33-83)	67.5 (29-88)	0.59
BMI *	23.4(18.2-42.8)	22.3 (17.5-27.8)	0.64
ASA classification (%)			0.51
Class 1	8 (40.0%)	6 (30.0%)	
Class 2	12 (60.0%)	14 (70.0%)	
Class 3	0	0	
Medical history (%)			0.68
Yes	3 (15.0%)	4 (20.0%)	
No	17 (85.0%)	16 (80.0%)	
Abdominal surgical history (%)			0.63
Yes	3 (15.0%)	2 (10.0%)	
No	17 (85.0%)	18 (90.0%)	
Depth of tumor invasion			0.67
Tis	1 (5.0%)	1 (5.0%)	
T1	7 (35.0%)	3 (15.0%)	
T2	3 (15.0%)	3 (15.0%)	
T3	6 (30.0%)	9 (45.0%)	
T4	3 (15.0%)	4 (20.0%)	
Lymph node metastasis			0.60
N0	16 (80.0%)	17 (85.0%)	
N1	3 (15.0%)	3 (15.0%)	
N2	1 (5.0%)	0	
Distant metastasis			1.00
M0	19 (95.0%)	19 (95.0%)	
M1	1 (5.0%)	1 (5.0%)	
Pathological TNM Stage			0.71
0	1 (5.0%)	1 (5.0%)	
I	9 (45.0%)	5 (25.0%)	
II	6 (30.0%)	10 (50.0%)	
III	3 (15.0%)	3 (15.0%)	
IV	1 (5.0%)	1 (5.0%)	
Maximum tumor diameter (cm) *	3.4 (0-8.7)	4.1 (0-7.8)	0.39

PSM: Propensity scores matching, BMI: Body mass index, ASA: American Society of Anesthesiologists,
Medical history: Diabetes mellitus and diseases of heart, lung, liver, kidney, brain and collagen
*Values are expressed as the median (range)

of the 39 IA group patients were matched with 20 of the 42 EA group patients (Figure 1). The demographic variables and preoperative status are presented in Table 1. Before PSM, median BMI, ASA classification and distant metastasis were significantly different between the two groups. The other characteristics, comorbidities, and risk factors, such as age, sex, medical history, abdominal surgical history, pathological depth of tumor invasion, lymph node metastasis, and TNM stage and maximum tumor diameter did not differ significantly between the two groups. However, after PSM, there were no significant differences in the demographic variables and preoperative status between the two groups.

Short-term outcomes

Short-term outcomes are presented in Table 2. Both before and after PSM, there were no significant differences in operative time and estimated blood loss. Furthermore, there were no significant differences in the numbers of days until first stool and solid diet and in postoperative length of stay between the two groups. Major complications such as wound infection, intra-abdominal abscess, ileus, and anastomotic leakage were similar between the groups. There was no mostly difference in postoperative pain in both groups. After PSM, in the IA group, the median length of the abdominal incision used for specimen extraction was 3.3 cm, compared to 5.0 cm in the EA group ($p<0.001$). Although takedown of the splenic flexure to fully mobilize the left hemicolon was mandatory in the EA group (95.0%), it was performed in only 5 patients (25.0%) in the IA group ($p<0.001$). The number of days until first flatus was less in the IA group (1 day) than in the EA group (2 days) ($p<0.05$).

Table 2: Short-term outcomes.

	IA group (N=39)	EA group (N=42)	*p* value
Before PSM			
Operative time (min) *	222 (146-530)	208.5 (120-360)	0.11
Blood loss (ml) *	10 (10-90)	10 (10-90)	0.44
Incision length (cm) *	3.5 (2-6.5)	4.75 (3-8)	<0.01
Mobilization of the splenic flexure (%)	10/39 (25.6%)	41/42 (97.6%)	<0.01
Time to first flatus (days) *	1 (0-3)	2 (1-4)	0.03
Time to first stools (days) *	2 (0-12)	3 (1-8)	0.25
Time to solid diet (days) *	3 (3-13)	3 (3-32)	0.69
Postoperative stay (days) *	11 (7-53)	11.5 (7-37)	0.25
Complications			
Wound infection (%)	3 (7.7%)	2 (4.8%)	0.58
Intra-abdominal abscess (%)	2 (5.1%)	3 (7.1%)	0.71
Ileus (%)	1 (2.6%)	2 (4.8%)	0.6
Anastomotic leakage (%)	1 (2.6%)	0	0.3
Pain scale *			
Day 0	43 (5-77)	48 (0-88)	0.58
Day 1	30 (0-80)	37 (9-83)	0.22
Day 2	26.5 (0-80)	37 (0-70)	0.49
Day 3	22 (0-75)	14 (0-86)	0.97
Number of additional analgesics *			
Day 0	1 (0-2)	1 (0-5)	0.18
Day 1	2 (0-5)	2 (0-5)	0.28
Day 2	1 (0-5)	1 (0-5)	0.76
Day 3	1 (0-3)	0 (0-4)	0.28
	N=20	N=20	
After PSM			
Operative time (min) *	220 (146-530)	203.5 (143-360)	0.24
Blood loss (ml) *	10 (10-90)	10 (10-190)	0.64
Incision length (cm) *	3.3 (2-5.5)	5 (4-8)	<0.01
Mobilization of the splenic flexure (%)	5/20 (25.0%)	19/20 (95.0%)	<0.01
Time to first flatus (days) *	1 (0-7)	2 (1-4)	0.03
Time to first stools (days) *	2 (0-12)	3 (1-7)	1
Time to solid diet (days) *	3 (3-13)	4 (3-12)	0.91
Postoperative stay (days) *	11 (7-42)	12 (8-22)	0.57
Complications			
Wound infection (%)	2 (10.0%)	2 (10.0%)	1
Intra-abdominal abscess (%)	1 (5.0%)	3 (15.0%)	0.29
Ileus (%)	1 (5.0%)	1 (5.0%)	1
Anastomotic leakage (%)	0	0	
Pain scale *			
Day 0	42.5 (5-77)	50 (0-88)	0.42
Day 1	38.5 (3-75)	33 (9-67)	0.69
Day 2	22.5 (0-67)	37 (5-65)	0.57
Day 3	25 (0-50)	18 (0-86)	0.85
Number of additional analgesics *			
Day 0	0 (0-2)	1 (0-5)	0.02
Day 1	2 (0-4)	2 (0-5)	0.96
Day 2	2 (0-4)	1 (0-5)	0.69
Day 3	1 (0-3)	1 (0-4)	0.66

PSM: Propensity scores matching, VAS: Visual Analogue Scale
*Values are expressed as the median (range)

Discussion

Laparoscopic surgery for colorectal cancer is spreading widely. Large comparative studies and multiple prospective, randomized, controlled trials have reported equivalent oncologic outcomes for open and laparoscopic resections for colon cancer [16,17]. In addition, these studies showed some advantages of laparoscopic resections over open colectomies [18,19].

Currently, technical advances and the development of new instruments have improved laparoscopic surgery. Adoption of totally laparoscopic resection with IA has spread gradually. Laparoscopic-assisted colectomy with EA technique requires extensive mobilization of the intestine and mesenteric traction to extract the intestine. In the EA group, when extracting the bowel, if the laparotomy is small, it is possible that bowel damage, bleeding, or release of cancer cells into the blood may occur due to the pressure of the tumor, so a sufficient length of incision is necessary. Furthermore, the EA technique limits the location of the extraction site and could compromise bowel alignment after extraction. On the other hand, in the IA group, because the bowel was resected intracorporeally, even with a small incision, bowel damage, bleeding, and release of cancer cells into the blood due to the pressure of the tumor did not occur at the time of specimen removal. Especially in obese patients, it is difficult to extract intestines through a thick abdominal wall with EA, so IA is better. Furthermore, in the IA technique, it has been suggested that infection may increase because the bowel is opened in the peritoneal cavity. Although not shown in the data, the serum C-reactive protein, an indicator of inflammation, and the number of days of fever (temperature ≥ 38°C) was higher in the IA group than in the EA group. However, there was no difference in the complications of both groups, and it seems that if sufficient intracorporeal washing is performed during surgery, the problem of infection can be controlled. In addition, the IA technique only requires the minimum necessary mobilization of the intestine and mesenteric traction, and it is sometimes possible to omit the troublesome take down of the colonic flexure. It is especially technically difficult to take down the left flexure, and it would be very helpful if that could be omitted, and in the present study, surgical cases limited to the treatment of left-side colon cancer near the junction of the sigmoid colon and descending colon were examined.

Several studies have recently compared the two techniques of laparoscopic right hemicolectomy with EA and totally laparoscopic right hemicolectomy with IA. Oncologic outcomes and anastomotic leak rates were equivalent for the two techniques. However, patients treated with IA had earlier return of bowel function, less pain, and a shorter hospital stay [7,9-12]. So far there have been some comparative studies of laparoscopic right colectomy with EA and IA, but there have been few comparative studies of laparoscopic left colectomy with EA and IA [13], because laparoscopic left colectomy is technically demanding [14]. The purpose of the present study was to compare these two techniques, limited to the treatment of left-side colon cancer near the junction of the sigmoid colon and descending colon. In this study, there were no significant differences in complications, operative times, and estimated blood loss, but the IA group had a smaller incision length, and the takedown of the splenic flexure could be omitted in some cases. Further, the number of days until first flatus was less in the IA group than in the EA group, which suggested that patients treated with IA had earlier return of bowel function. IA is an alternative approach that may alleviate some of the technical problems associated with EA for left-side colon cancer. In the future, it will be necessary to assess the long-term oncological outcomes of this technique.

Conclusion

A totally laparoscopic colectomy with IA for left-side colon cancer is technically feasible and can be performed with good cosmetic outcomes and decreased time to first flatus, suggesting faster recovery. Further investigations are needed to assess the oncological outcomes of this technique.

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