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Short-term Outcomes of Robotic Left Colectomy Reconstructed by Intracorporeal Overlap Anastomosis for Left-sided Colon Cancer: A Single-center Report from Japan

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Abstract. *Background/Aim: Surgery for colon cancer requires covering a wide area and performing both tumor resection and precise lymph node dissection. Robotic left-sided colectomy (RLC) has not been thoroughly established due to the rarity of descending colon cancer. Therefore, we investigated 19 patients who underwent RLC for left-sided colon cancer. Patients and Methods: Between January 2023 and July 2024, a total of 19 consecutive patients underwent robotic radical left colectomy, which included mobilization of the splenic flexure. We compared the intra- and postoperative factors between left-sided colectomy with and without stent placement. Results: Total operative time (p=0.002), console time (p=0.001), and lymph node harvest time (p=0.001) were significantly different. The total operative time with stent placement was longer than that without stent placement (421.6 vs. 302.0, p<0.01). Console time with stent placement was longer than that without stent placement (315.0 vs. 202.0, p<0.01). More lymph nodes were harvested with stent placement than without (33.1 vs. 11.0, p<0.01). Conclusion: We did not experience any conversions to open surgery, and two Grade II complications were observed according to the Clavien–Dindo classification. Both total operative and console times were longer in cases with stent placement compared to those without. Nevertheless, we safely performed robotic left colectomy, regardless of whether the left-sided colon cancer was treated with stent placement, even in cases where the anastomosis overlapped naturally. Our postoperative outcomes showed no anastomosis-related complications. Therefore, RLC reconstruction using an intracorporeal overlap anastomosis is feasible for left-sided colon cancer, both in terms of intraoperative and postoperative outcomes.*

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Key Words: Robotic left colectomy, intracorporeal anastomosis, overlap anastomosis.

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As of April 2022, robotic colectomy is covered by insurance in Japan. The robotic approach is mainly used for right-sided colectomy as the occurrence site of colorectal cancer was as follows: rectum, 37.9%; sigmoid colon, 34.3%; ascending colon, 10.4%; transverse colon, 7.0%; cecum, 5.9%; and descending colon, 4.5% (1). Thus, the incidence rate of right-sided colon cancer is approximately 20% compared with the 4.5% of descending colon cancer.

Surgery for colon cancer necessitates extensive coverage to ensure thorough tumor resection and precise lymph node dissection. Recently, a robotic platform featuring magnified three-dimensional visualization, a stable platform, and a seven degrees-of-freedom wrist has shown promise in performing more precise and delicate procedures, particularly for colon cancer.

Robotic right-sided colectomy is becoming more widespread and standardized in Japan because Japanese insurance covers it. However, robotic left-sided colectomy has not been thoroughly established due to the rarity of descending colon cancer. Therefore, each center adopted its own approach and method. We here introduce our unique procedure, robotic left colectomy, reconstructed by intracorporeal overlap anastomosis for left-sided colon cancer, and discuss the short-term outcomes.

Patients and Methods

Study population and data collection. This was a retrospective study of patients who underwent robotic left colectomy reconstructed using intracorporeal overlap anastomosis for left-sided colon cancer. All consecutive 19 patients who underwent robotic radical left

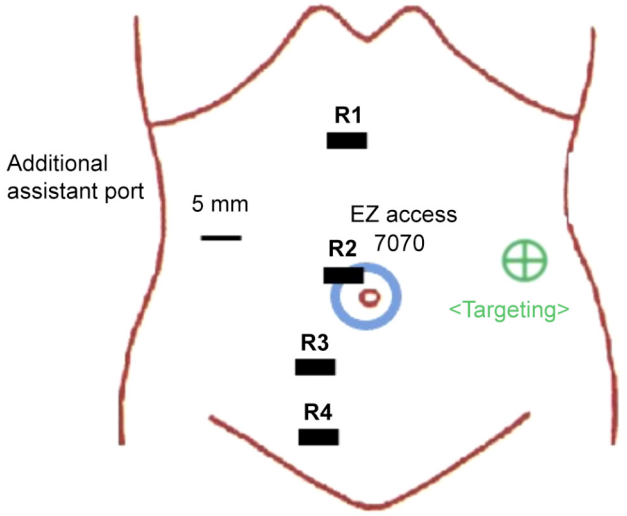

Figure 1. *Port replacements. An initial 3-5-cm intraumbilical incision was made. A LapProtector Mini (HaKKO Co., Nagano, Japan) was placed and inserted using the EZ ACCESS KIT (HaKKO Co.).*

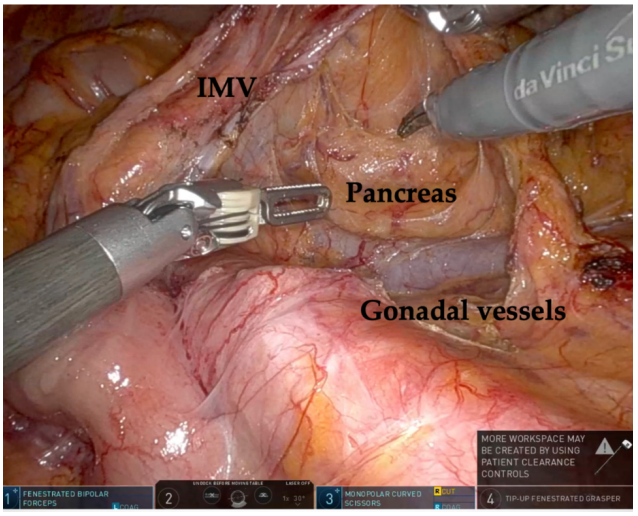

Figure 2. *Intraoperative findings. We performed exfoliation under the inferior mesenteric vein between the mesocolon of the descending colon and retroperitoneal fascia to reach the inferior pancreatic border.*

colectomy with mobilization of the splenic flexure between January 2023 and July 2024 were included.

During this period, we performed 65 colectomies for colonic cancer, and 19 (29.2%) of 65 patients underwent colectomy for left-sided colon cancer. Written informed consent was obtained from all patients for performing the operation and publication of this report. This study was approved by the ethics committee of our hospital (approval number: SH2018-004).

Surgical technique (2). An initial 3-5-cm intraumbilical incision was made. A Lap-Protector Mini (HaKKO Co., Nagano, Japan) was placed and inserted through the EZ ACCESS KIT (HaKKO Co.). EZ ACCESS with two trocars was attached to the Lap-Protector Mini, and two 8-mm (R1 and R4) and 12-mm (R3) robotic arm trocars were inserted through the R2 camera. R1 was in the middle of the upper abdomen, and R3 and R4 were in the right lower quadrant. An additional assistant 5-mm laparoscopic port was placed in the right upper quadrant between R1 and R2 (Figure 1).

We dissected and isolated the inferior mesenteric vein (IMV) at the inferior pancreas border (Figure 2). Then, we dissociated the inferior mesenteric artery (IMA) and ligated the left colonic artery while preserving the superior rectal artery and part of the sigmoid artery. Consequently, we performed lymph node dissection (D3) (Figure 3).

A robotic linear stapler (R3: SureFormTM60 Green) was used to divide and close the specimen to maintain a secure distance of ≥10 cm for the proximal and distal resection margins. Two stapler limbs were created. In firefly mode, the distal and proximal colic limbs were laid in an overlapping fashion. Each anvil of the robotic linear stapler (R3: SureFormTM60 Blue) was subsequently inserted into the holes and fired (Figure 4). Finally, a robotic left colectomy, reconstructed using an intracorporeal overlap anastomosis, was completed.

Comparison of patient characteristics, intraoperative variables, and postoperative outcomes between left-sided colectomy with stent placement and without stent placement. The inclusion criterion was malignant left-sided colon tumors. Patients with stages I-IV disease were included in the present study. The following information was retrospectively collected: age, sex, body mass index (BMI), tumor staging, preoperative self-expandable metallic stent placement for left-sided colon cancer, previous laparotomy, and American Society of Anesthesiologists (ASA) classification (3). We assessed intraoperative and postoperative outcomes, including mean operative time, console time, anastomosis time, estimated blood loss, number of lymph nodes harvested, unplanned conversion to open surgery, postoperative complications (morbidity) according to the Clavien–Dindo grade, mean length of postoperative hospital stay, and 30-day readmissions. We also compared the intra- and postoperative factors of between left-sided colectomy with and without stent placement.

Results

Patient characteristics are shown in Table I. There were 10 females and 9 males, with a median age of 72.3 years (range=47-84 years) and a median body mass index (BMI) of 21.8 kg/m2 with a range of 16.8-26.8 kg/m2. Fourteen patients were diagnosed with descending colon cancer. Two patients were diagnosed with transverse colon cancer, and three were diagnosed with sigmoid colon cancer. Five patients were classified as stage I, eight patients as stage II, four as stage III, and two as stage IV. Four patients had undergone a previous laparotomy for acute appendicitis. Most patients had an ASA score of 1 (nine cases) or 2 (nine cases), followed by one patient with an ASA score of 3. No patient had an ASA score of 4, indicating a life-threatening

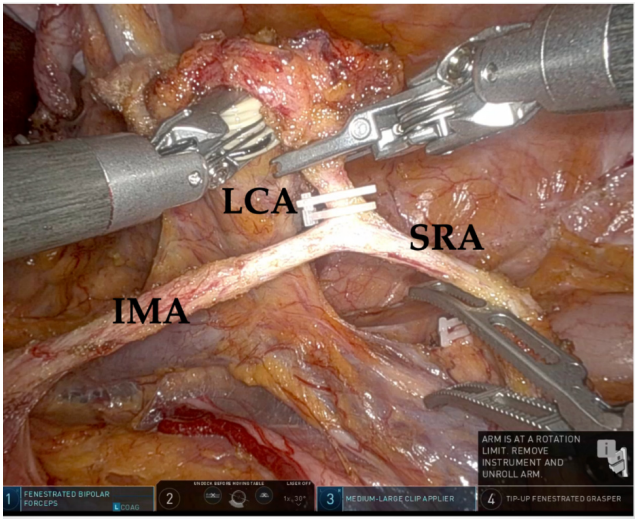

Figure 3. *Intraoperative findings. We dissociated the inferior mesenteric artery (IMA) and ligated the left colonic artery (LCA) while preserving the superior rectal artery (SRA), thereby completing lymph node dissection (D3).*

Figure 4. *Intraoperative findings. Each anvil of the robotic linear stapler (R3: SureFormTM60 Blue) was inserted into the respective hole and activated.*

condition. Eight patients underwent robotic left colectomy with stent replacement. Intraoperative variables and postoperative outcomes are shown in Table II.

The median operative time was 344.8 min, and the mean console time of the da Vinci Xi robotic platforms was 251.4 min. The mean time for overlap anastomosis was 35.5 min. The median estimated blood loss was 40.6 g. The mean number of lymph nodes harvested was 20.3. We had no experience in converting robotic left colectomy procedures to open surgery. According to the Clavien–Dindo classification,

Table I. *Patient characteristics.*

Characteristic	Patients, n=19
Age (years)	72.3 (47-84) years
Sex Male:Female	9:10
Body Mass Index (kg/m^2)	21.8 (16.8-26.8)
Location: Transverse/Descending/ Sigmoid colon	2/14/3
TNM tumor staging	
Stage I	5
Stage II	8
Stage III	4
Stage IV	2
Preoperative stent placement or not (With stent placement: Without stent placement)	8:11
Previous laparotomy	4 cases (All acute appendicitis)
ASA-Classification 1/2/3/4	ASA 9/9/1/0

Table II. *Intraoperative variables and postoperative outcomes.*

Mean operative time (min)	344.8 min
Mean console time (min)	251.4 min
Mean anastomosis time (min)	35.5 min
Bleeding in operation (ml)	40.6 ml
Lymph node harvested (mean)	20.3
Conversion to open surgery	None
Any complication	Fluid connection/Herpes zoster
Major morbidity (>II Clavien-Dindo grade)	Clavien-Dindo II 2 cases
Mean length of postoperative hospital stay	15.8 days
30-days readmission	None

two grade II complications were observed: a fluid collection and herpes zoster. The mean length of postoperative hospital stay was 15.8 days. There were no 30-day readmissions among the 19 patients.

Total operative time (p=0.002), console time (p=0.001), and lymph node harvest time (p=0.001) were significantly different. The total operative time with stent placement was longer than that without stent placement (421.6 *vs*. 302.0 min, p<0.01). Console time with stent placement was longer than that without stent placement (315.0 *vs*. 202.0 min, p<0.01). More lymph nodes were harvested with stent placement than without (33.1 *vs*. 11.0 min, p<0.01). There were no significant differences in other factors (Table III).

Discussion

A robotic system using the da Vinci Xi robotic platform (Intuitive Surgical Sunnyvale, CA, USA) has been increasingly adopted for the management of colorectal resection of

Table III. *Comparison of robotic left colectomy between with and without preoperative stent placement for left-sided colon cancer.*

	With stent placement, n=8	Without stent placement, n=11	*p*-Value
Mean operative time (min)	421.6 min	302.0 min	0.002
Mean console time (min)	315.0 min	202.0 min	0.001
Mean anastomosis time (min)	38.1 min	35.3 min	0.19
Bleeding in operation	61.3 ml	25.5 ml	0.09
Lymph node harvested (mean)	33.1	11.0	0.001
Conversion to open surgery	None	None	–
Any complication	Herpes zoster	Fluid connection	–
Major morbidity (>II Clavien-Dindo grade)	Clavien-Dindo II 1 case	Clavien-Dindo II 1 case	–
Mean length of postoperative hospital stay	17.0 days	14.3 days	0.34
30-days readmission	None	None	–

malignant tumors. Robotic procedures are mostly established for rectal cancer and right-sided colon cancer; however, the procedure for left-sided colon cancer, which requires mobilization of the splenic flexure, has not yet been established due to its low occurrence rate and the complexity of mobilizing the splenic flexure. Moreover, there are relatively few studies on the outcomes of robot-assisted tumor resection for left-sided colon cancer. Therefore, a procedure for treating left-sided colon cancer should be established.

We investigated 19 patients who underwent robotic left colectomy and lymph node dissection for left-sided colon cancer. Consequently, we had no experience with conversion to open surgery, and two complications were observed as Grade II according to the Clavien–Dindo classification. Our procedure for left-sided colon cancer was safely performed in terms of short-term outcomes, including both intraoperative and postoperative outcomes. However, long-term outcomes, including overall and disease-free survival, were unknown in our study.

Regarding short-term outcomes, Leonardo *et al*. (4) concluded that robotic left colectomy requires less conversion to open surgery than the standard laparoscopic approach. Postoperative morbidity rates seem to be lower during RLC. According to another study, the rates of overall complications, anastomotic leakage, and wound infections decrease after RLC (4-6).

We compared the intra-and postoperative factors between left-sided colectomy with and without stent placement. There were no significant differences between them, except for total operative time, console time, and lymph node harvest. The total operative and console times with stent placement were longer than those without stent placement. Therefore, our procedure with stent placement took longer than the conventional procedure (without stent placement). Left-sided colon cancer with stent placement is difficult to treat surgically.

The long-term survival of left-sided colectomy with stent placement remains controversial; however, the short-term outcomes are comparable to those without stent placement (7, 8). We safely performed robotic left colectomy, regardless of whether the left-sided colon cancer was treated with stent placement, even if the anastomosis overlapped naturally. More lymph nodes were harvested with stent placement than without. There have been no reports indicating that colon cancer with stent placement results in a significantly higher number of lymph nodes harvested or an increased incidence of metastasis (9). We hypothesized that inflammatory changes due to stent placement might have increased the number of harvested lymph nodes. However, the increase in the number of metastatic lymph nodes has not been proven in our study. Accordingly, RLC is a feasible procedure for treating left-sided colon cancer.

The most common postoperative complication is predominantly anastomotic leakage. The Fire–Fly mode in the da Vinci Xi system could significantly eliminate one of the causes of leakage. Currently, indocyanine green fluorescence imaging has been proven to be effective for the treatment of anastomotic leakage, rectal cancer, and colon cancer (10, 11). We performed RLC for left-sided colon cancer, and its anastomosis was reconstructed using the intracorporeal overlap method in the Fire-Fly mode in our institution. There is no significant difference among intracorporeal anastomoses, such as delta-shaped and overlapping, even for extracorporeal anastomoses (12-14). The mean duration of anastomosis time was 35.5 min. Postoperative outcomes showed no anastomosis-related complications. Therefore, our overlap anastomosis for left-sided colon is a feasible procedure.

In conclusion, our surgical procedure for robotic left colectomy, reconstructed using intracorporeal overlap anastomosis for left-sided colon cancer, is feasible with respect to intraoperative and postoperative outcomes.

Conflicts of Interest

All Authors declare no potential conflicts of interest regarding the research, authorship, or publication of this article.

Authors' Contributions

All Authors contributed to the study's conception. Toshikatsu Nitta and Masatsugu Ishii performed material preparation, data collection, and analysis. Toshikatsu Nitta wrote the first draft of the manuscript. All Authors critically revised the manuscript. All Authors read and approved the final manuscript.

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