

## Short-term Outcomes of Robot-assisted Colectomy Using the Overlap Method for Right-sided Colon Cancer

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**Abstract.** *Background/Aim:* The recent development of minimally invasive surgery has led to transition from laparoscopic right colectomy (LC) to robot-assisted right colectomy (RC) in Japan. However, it is unclear whether the introduction of RC in municipal hospitals could be as safe as that in high-volume centers in Japan. Therefore, this retrospective study aimed to compare the short-term operative outcomes of RC and LC for right colon cancer at a local municipal hospital in Japan. *Patients and Methods:* Patients with stage I-IV right colon cancer who underwent elective RC or LC between January 2021 and July 2023 were retrospectively analyzed. Patients with double cancer and those who underwent delta anastomosis were excluded. Postoperative surveillance included patient interviews, physical examinations, tumor marker examinations, and whole-body computed tomography every six months. *Results:* Forty patients were analyzed, and 24 (60%) and 16 (40%) patients assigned in the LC and RC groups, respectively, were compared. The operative time, bleeding, postoperative complications, and pathological examinations did not differ significantly between the LC and RC groups. *Conclusion:* RC using overlapping anastomoses was comparable to LC in

terms of short-term operative outcomes. The introduction of RC with overlapping anastomosis is a feasible surgical technique.

Performance of robot-assisted colon surgery (RCS) was first reported by Weber *et al.* (1). Before the introduction of RCS, laparoscopic colon surgery (LCS) was reported to be associated with reduced overall morbidity, shortened length of hospital stay, faster recovery of oral intake, and improved intestinal function compared with open surgery (2-4). The development of minimally invasive surgery has led to increased transition from LCS to RCS over the last decade in Japan. However, few reports have made a comparison between RCS with overlapping anastomoses and LCS for right-sided colon cancer. Moreover, it is unclear whether the introduction of RCS in municipal hospitals could be as safe as that in high-volume centers. Therefore, this study aimed to compare the short-term outcomes of patients who underwent RCS and LCS at a local municipal hospital in Japan.

### Patients and Methods

We retrospectively evaluated consecutive patients who underwent elective laparoscopic surgery and robot-assisted surgery using the overlap method for right colon cancer at the Division of Surgery, Gastroenterological Center, Medico Shunju Shiroyama Hospital between January 2021 and July 2023. The overlap anastomotic method was introduced in our hospital for patients with early to advance stage colon cancer who undergo LCS. The study protocol was approved by the Division of Surgery, Gastroenterological Center, Medico Shunju Shiroyama Hospital, Habikino, Japan (approval number: 2018-004, and the study was performed in accordance with the Declaration of Helsinki. Standard procedures were similar for all patients and were performed by the same surgical team. Patients with double cancer or delta anastomosis were excluded. Written consent has been obtained from all patients and relevant persons (such as the parent or legal guardian) to publish the information, including photographs.

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**Key Words:** Laparoscopic, robot-assisted, colectomy, overlap anastomosis, colon cancer, right-sided.

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**Operative procedure.** We used six trocars, and the port placement is presented in Figure 1. After maintaining the intra-abdominal pressure at 10 mmHg at pneumoperitoneum, the patients were positioned in a 0-15° head-down position and tilted 10° to the left. A technique with a robotic procedure using the da Vinci® Xi surgical system (Intuitive Surgical, Sunnyvale, CA, USA) was employed for all procedures with a retroperitoneal approach. After bowel and intestinal mobilization and lymphadenectomy, the patient was positioned at 3° head-up; a cranial approach was used at the hepatic curvature.

**Laparoscopic colectomy (LC) or robot-assisted colectomy (RC) with overlap anastomosis.** A small trocar incision was made at the umbilical port. In the case of extracorporeal anastomosis, the bowel was externalized after protecting with a wound protector. The ileum or colon was resected using 60-mm linear staplers, and ileocolostomy was performed using a 60-mm linear stapler. The enterotomy was closed using verbed sutures.

In RC with overlap anastomosis, the ileum or colon was resected intracorporeally with 60-mm linear staplers, and the enterotomy was closed using the Albert-Lembert method after performing a side-to-side ileocolostomy with a 60-mm linear stapler. The specimen was then extracted through mini-laparotomy over the transumbilical port site. A drainage tube was placed after surgery.

**Surveillance after surgery.** Surveillance after surgery was performed in accordance with the Japanese guidelines. Briefly, the patients underwent interviews, physical examinations, tumor marker examinations, and whole-body computed tomography every six months.

**Statistical analysis.** Statistical analysis was performed using the EZR software (Saitama Medical Center, Jichi Medical University, Saitama, Japan). The two groups were classified as independent, unpaired groups. Data are expressed as average with mean±standard error. The statistical significance of the data was determined using the one-way analysis of variance, Fisher's exact, chi-squared, or Student's *t*-test. Statistical significance was set at  $p < 0.05$ .

## Results

A total of 40 patients were analyzed. The preoperative baseline patient characteristics are shown in Table I. The operative, pathological, and oncological findings are presented in Table II. Diverting ileostomy was performed in 1 of the 40 anastomosed patients (2.5%). Only patients with thromboembolic lower-limb arterial occlusion were treated with catheter dilation therapy, and the other conditions were managed conservatively. Finally, 16 patients in the RC group and 24 patients in the LC group were compared and analyzed (Table III). Two patients in the LC group required conversion to open surgery. The operative time, bleeding, distal and proximal resection margins, length of skin incision, postoperative complications, and postoperative length of hospital stay were not significantly different between the LC and RC groups.

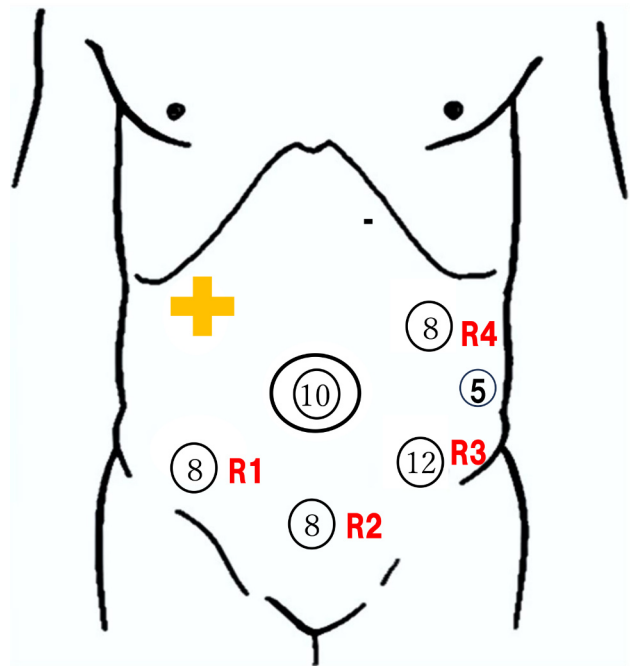


Figure 1. Port placement in robot-assisted colectomy. R1: 8 mm port; R2: 8 mm port; R3: 12 mm port; R4: 8 mm port; Naval: 10 mm port; Assist: 5 mm port; +: targeting.

## Discussion

As a technological advance, RC has minimized enhanced camera guidance, tremors, and articulated functions within a few years in Japan, all of which have improved dissection. These methods have been improved to simplify the dissection in the deep and narrow pelvis (5-8). Short-term outcomes and benefits of RC compared with that of LC have been reported in randomized controlled trials. A systematic review and meta-analysis by Cuk *et al.* (9) was the first to compare robot-assisted surgery with laparoscopic surgery for colon cancer resections. That study, which included 14,093 patients and reported the short-term clinical outcomes, indicated that RCS was superior to LCS in terms of anastomotic leakage rate, overall complication rate, conversion to open surgery, and time to start a regular diet. Despite the lack of prospective studies included in the meta-analysis, these results were confirmed by supplementary statistical analyses. These results indicate that the robot-assisted method has several clinical benefits compared with laparoscopy in predominantly right-sided tumors, which may defend its standardized implementation for the future treatment of right-sided colon cancer. Our robotic approach of overlapping anastomosis results showed that RC with overlap is similar to LC with overlap. We applied the robot-assisted overlap technique in RC and compared its short-term effects with those of LC. Some researchers worry about technical difficulties and long operation times because of anastomosis

Table I. Preoperative characteristics of 40 patients.

Characteristic	Value
Age at surgery, years	75.2±10.8 (47-90)
Sex	
Male	21 (52.5%)
Female	19 (47.5%)
BMI, kg/m <sup>2</sup>	22.4±6.4 (14-56)
ASA classification	
II	1.9±0.53 (1-3)
Tumor location	
Cecum	12 (30%)
Ascending colon	20 (50%)
Transverse colon	8 (20%)

Data are expressed as mean±standard error (range) or number (percentage). BMI: Body mass index; ASA: American Society of Anesthesiologists.

(10). We began performing robot-assisted colorectal surgery in January 2023. Our Department of Surgery established seven staff surgeons during the study period. In this study, a surgeon with expertise in the laparoscopic and colorectal fields, but without experience in robotic surgery, visited another hospital where RCS was introduced to other non-expert members to evaluate its feasibility.

In the introduction of LCS, the primary difficulty was the high rate of conversion to open surgery and intraoperative complications (11-15). Several studies have reported that the introduction of robot-assisted rectal surgery (RRS) is safe and feasible at high-volume centers worldwide. Park *et al.* reported an overall morbidity rate of 29.3% including an anastomotic leakage rate of 9.7%, and the incidence of major complications was 9.8% in their first 41 cases of RRS (16). In colon cancer, the colonic mesentery is oncologically responsible for the vascular and lymphatic drainage of the colon, and complete mesocolic excision (CME) shares similarities with the concept and surgical technique used for total mesorectal excision in rectal cancer. Previous studies have shown that CME is oncologically beneficial (17). The reason for this was thought to be the several possible advantages of the RRS over laparoscopic rectal surgery. This is because the instruments are designed to move seven degrees of motion, which is greater than the angle of the human wrist and provide a three-dimensional surgical view and steadiness. Robot-assisted right colon resection with intracorporeal anastomosis was reported by Trastulli *et al.* (18) to be feasible and safe. In our study, operative time, bleeding, and complications were not significantly higher in the RC group than in the LC group. We are concerned that the reason for our short-term robotic outcomes is the standardization of port placement and technical procedures. This indicated that the robot-assisted method had some clinical benefits compared with laparoscopy for right-sided tumors, which may defend its standardized

Table II. Operative, pathological, and oncological characteristic of all patients (N=40).

Results	Value
Surgical procedure	
Ileocecal resection	14 (35%)
Right colectomy	6 (15%)
Right hemicolectomy	15 (37.5%)
Transverse colectomy	5 (12.5%)
Operative time, min	345.5 (204-534)
Bleeding, ml	63.3±138.5 (5-580)
T stage	
Tis(M)	4 (10%)
T1b	5 (12.5%)
T2	4 (10%)
T3	23 (57.5%)
T4a	2 (5%)
T4b	2 (5%)
LN metastasis	
Yes	11 (27.5%)
No	29 (72.5%)
TNM staging	
0	3 (7.5%)
I	10 (25%)
IIa	15 (37.5%)
IIb	2 (5%)
IIIa	1 (2.5%)
IIIb	3 (7.5%)
IIIc	3 (7.5%)
IVa	3 (7.5%)
Tumor size, mm	43.2±22.8 (8-115)
Distal margin, mm	103.5±54.2 (20-250)
Proximal margin, mm	95.2±53.1 (14-230)
Number of harvested lymph nodes	22.8±9.65 (3-43)
Postoperative length of hospital stay, days	15.3±7.06 (8-30)
Postoperative complications (CD>III)	
Ileus (ileus tube)	1 (2.5%)
Thromboembolic lower limb arterial occlusion	1 (2.5%)
Recurrence	
Liver/Lung	2 (5%)
Dissemination	1 (2.5%)

Data are presented as mean±standard error (range) or number (percentage). LN: lymph node; CD: Clavien–Dindo classification.

implementation for the future treatment of right-sided colonic cancer. However, that was a non-randomized retrospective study, and the overlapping series was limited; therefore, the quality of evidence in that study was low. However, our results showed that RCS was associated with several beneficial outcomes. There are a few reports on the effectiveness of overlap anastomosis in patients who underwent RCS (9). With the introduction of robotic surgery, we have performed an overlapping method for right colic cancer. In the case of laparoscopic surgery, it is sometimes difficult to use intracorporeal anastomosis because of the lack of a fitting angle of the staple. Moreover, in cases of massive tumors such as T4 and obesity, we are concerned about the use of overlap

Table III. Patient and operative characteristics based on the surgery performed (N=40).

Characteristic	LC, N=24	RC, N=16	p-Value
Age, years	73.7±12.5	77.3±7.4	0.32
Sex, Male/Female	12/12	9/7	0.71
BMI kg/m <sup>2</sup>	22.7±7.8	21.8±3.5	0.66
ASA classification II	1.87±0.61	2.0±0.3	0.46
Tumor location			0.19
Cecum	7	8	
Ascending colon	10	7	
Transverse colon	7	1	
Operative time, min	354.0±88.0	332.7±47.7	0.38
Bleeding, ml	91.8±174.0	20.6±14.8	0.11
Tumor size, mm	43.5±28.4	42.4±10.3	0.87
Distal margin, mm	107.7±59.2	97.3±46.9	0.56
Proximal margin, mm	93.3±58.3	98.1±46.0	0.78
Number of harvested lymph nodes	23.3±10.5	22.1±8.4	0.69
Postoperative length of hospital stay, days	14.4±6.9	16.6±7.1	0.32
Complications (Clavien–Dindo>III)			0.24
Ileus (ileus tube)	1	0	
Thromboembolic lower limb arterial occlusion	1	0	
Recurrence			0.53
Liver/Lung	2	0	
Dissemination	1	0	

Data are presented as mean±standard error or numbers. BMI: Body mass index; ASA: American Society of Anesthesiology; LC: laparoscopic colectomy; RC: robot-assisted colectomy.

anastomosis; therefore, we performed intra- or extracorporeal anastomosis after right-sided colon mobilization and lymph node dissection. We believe that, by using different suturing devices depending on the tumor situation, it is possible to perform adequate anastomosis. With an increasing number of robots, we believe that our overlap anastomotic technique will be safe, and the introduction of RCS will be facilitated.

In conclusion, this pilot study demonstrated that RC was safe and feasible, given that surgeons had sufficient skill and experience in both LC and colorectal surgery, and were provided advice from experienced outside proctors in the initial phase.

### Conflicts of Interest

The Authors declare that there are no conflicts of interest in relation to this study.

### Authors' Contributions

MI acquired data and drafted the manuscript. TN, MO, YU, MT, RK and TI drafted the manuscript. TN revised the manuscript critically. All the Authors have read and approved the final manuscript.

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