

# Comparison of Intracorporeal Isoperistaltic and Antiperistaltic Anastomoses in Robotic-assisted Surgery for Right-sided Colon Cancer

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## Abstract

**Background/Aim:** To date, several clinical trials have compared isoperistaltic and antiperistaltic anastomosis; however, in the context of robot-assisted surgery (RAS), a consensus on the optimal approach has yet to be established. This study aimed to compare the short-term outcomes of intracorporeal isoperistaltic and antiperistaltic side-to-side anastomoses in RAS for right-sided colon cancer.

**Patients and Methods:** A retrospective subgroup analysis was conducted using a database collected from a Japanese multicenter prospective study. Patients diagnosed with curatively resectable right-sided colon cancer (cStage I-IIIC) who underwent RAS with intracorporeal anastomosis were included. Surgical and postoperative outcomes were compared between the isoperistaltic and antiperistaltic anastomosis groups.

**Results:** Among the 78 patients analyzed, 23 (29.5%) underwent antiperistaltic anastomosis and 55 (70.5%) underwent isoperistaltic anastomosis. There were no significant differences in age, sex, American Society of Anesthesiologists Physical Status score, previous abdominal surgical history, or clinical stage between the groups. Isoperistaltic anastomosis was more frequently performed in ascending and transverse colon cancers, whereas antiperistaltic anastomosis was more frequent in cecal cancers. Right hemicolectomy was significantly more frequent in the isoperistaltic group than in the antiperistaltic group (92.7% vs. 60.9%) ( $p=0.0014$ ). The total operative time was longer in the antiperistaltic group, but the console and anastomosis times were comparable. No intraoperative

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complications, conversions, or transfusions were reported. Postoperative complication rates were similar between the two groups.

**Conclusion:** This study demonstrated equivalent short-term outcomes between intracorporeal isoperistaltic and antiperistaltic anastomoses in RAS for right-sided colon cancer. Both techniques appear to be safe and effective, supporting the recommendation that surgeons maintain proficiency in both methods to allow flexibility based on intraoperative conditions.

**Keywords:** Intracorporeal anastomosis, colon cancer, robotic surgery, isoperistaltic, antiperistaltic.

## Introduction

Minimally invasive surgery (MIS) has become a standard procedure for colorectal cancer surgery. Extracorporeal anastomosis (EA) is commonly used in MIS for colon cancer owing to its technical ease and short operative time; however, EA requires extensive bowel mobilization to guide the intestine out of the peritoneal cavity, which may cause mesenteric injury, adversely affecting the recovery of intestinal peristalsis after surgery. Intracorporeal anastomosis (IA) has recently gained attention owing to the development of new equipment and suturing techniques such as linear staplers and barbed sutures. IA tends to require longer operative time but is associated with smaller open wounds and faster recovery of postoperative intestinal peristalsis (1, 2).

The use of robotic-assisted surgery (RAS) for the treatment of colon cancer has increased rapidly in recent years. Cohort studies and meta-analyses have shown that RAS for colon cancer is superior to conventional laparoscopic surgery (CLS) in short-term outcomes, including lower open conversion rates and complication rates, shorter hospital stay, and greater number of dissected lymph nodes (3-10). Although reports on recurrence and survival rates are limited, RAS is reported to be comparable to CLS (9, 11-13). Furthermore, RAS is expected to facilitate IA because of its technical advantages. In several clinical trials, IA is often performed in RAS over CLS (14, 15).

Intracorporeal side-to-side anastomosis involves the reconstruction of the two segments in isoperistaltic or antiperistaltic orientation. Isoperistaltic side-to-side

anastomosis, termed as overlap anastomosis, is considered the most common anatomical reconstruction because it is consistent with the physiological flow of the intestinal contents. In contrast, antiperistaltic anastomosis has been shown to potentially prevent mesenteric torsion seen in isoperistaltic anastomosis, which potentially reduces the incidence of postoperative bowel obstruction. Antiperistaltic side-to-side anastomosis is termed as functional end-to-end anastomosis.

To date, several clinical trials comparing isoperistaltic and antiperistaltic anastomosis have been conducted; however, no consensus on the more desirable anastomosis has been reached (16, 17). We performed an exploratory study using a database of Japanese multicenter prospective study to compare the short-term results of intracorporeal isoperistaltic and antiperistaltic anastomoses in RAS.

## Patients and Methods

**Patient selection.** A previous multicenter, prospective, single-arm, open-label, observational study was conducted from July 2019 to March 2022 to evaluate the non-inferiority of RAS to CLS for right-sided colon cancer in terms of open conversion rate. Eligible patients were diagnosed with curatively resectable cStage I-IIIC (T1-4b, N0-2b, M0) right-sided colon cancer with D2 or D3 lymph node dissection (18). Other selection criteria have been described previously (10). This prospective study was registered with the Japan Registry of Clinical Trials. The registration number is jRCT1032190036 (<https://jrct.niph.go.jp/latest-detail/jRCT1032190036>).

In the present study, a retrospective subgroup analysis was conducted to clarify the short-term results of intracorporeal isoperistaltic and antiperistaltic side-to-side anastomosis in RAS using the data from the prospectively collected database. The data of patients who underwent IA in the primary endpoint analysis population were used in this analysis. This study was approved by the Institutional Review Board of the Shizuoka Cancer Center (CRB3180020-NR2019-001) and informed consent was obtained from all the participants. This study was performed following the Helsinki Declaration of 1964, as revised in 2013.

**Surgical procedure.** RAS for right-sided colon cancer with D2 or D3 lymph node dissection was performed in all patients using the da Vinci Xi surgical system. All procedures were performed by seven expert console surgeons who had performed more than 50 cases of RAS for rectal cancer and were certified by the Japan Society for Endoscopic Surgery and board-certified in gastroenterology by the Japanese Society of Gastroenterological Surgery.

After colectomy, a side-to-side antiperistaltic or isoperistaltic stapled anastomosis was performed intracorporeally. For each anastomosis, both ends of the intestine were placed in an isoperistaltic or antiperistaltic orientation. Enterotomies were performed on the antimesenteric sides of the ileum and colon. Next, a side-to-side anastomosis was performed using a linear stapler. The enterotomy was closed using a stapler or a barbed suture. The choice of IA or EA was not specified in the protocol and was left to the judgment of each surgeon. In IA, the choice of isoperistaltic and antiperistaltic anastomosis was also left to the judgment of each surgeon.

**Outcome variables.** The patients were classified into antiperistaltic and isoperistaltic anastomosis groups. The clinical features and surgical outcomes were compared between the two groups, and the following factors were analyzed: age, sex, body mass index (BMI), American Society of Anesthesiologists Physical Status (ASA-PS), abdominal surgical history, tumor location, clinical stage,

and mechanical and chemical bowel preparations. The surgical factors and outcomes included type of surgery, extent of lymph node dissection, conversion, intraoperative complications, blood loss, transfusion, operative time, and construction time. Postoperative complications were evaluated based on the Clavien-Dindo classification (19).

**Statistical analysis.** Fisher's exact test or the chi-square test was used to assess categorical variables, and the Mann-Whitney *U*-test was used to compare continuous variables between the two groups. Statistical significance was set at  $p<0.05$ . All analyses were performed using Bell Curve for Excel (version 2.15; Social Survey Research Information Co. Ltd., Tokyo, Japan).

## Results

**Patient characteristics.** A total of 78 patients who underwent RAS with IA for right-sided colon cancer were analyzed. The characteristics of 23 (29.5%) patients who underwent antiperistaltic anastomosis and 55 (70.5%) patients who underwent isoperistaltic anastomosis are summarized in Table I. There were no significant differences between the groups in terms of age, sex, ASA-PS score, abdominal surgical history, and cStage. The BMI was significantly higher in the isoperistaltic anastomosis group than in the antiperistaltic anastomosis group. The tumor locations differed significantly between the two groups. Compared to the isoperistaltic anastomosis group, the antiperistaltic anastomosis group had more tumors in the cecum (39.1% vs. 9.1%) and less in the ascending colon (56.5% vs. 74.5%) and transverse colon (4.3% vs. 16.4%). Chemical bowel preparation was performed significantly more frequently in the isoperistaltic anastomosis group than in the antiperistaltic anastomosis group (94.5% vs. 73.9%); however, there was no significant difference in the frequency of mechanical preparation between the groups.

**Operative results.** The details of the surgery and intraoperative surgical outcomes are summarized in Table II. Right hemicolectomy was performed significantly more

Table I. Demographic and clinicopathological characteristics of the study cohort.

	Anti-peristaltic anastomosis n=23	Iso-peristaltic anastomosis n=55	p-Value
Age, years (median, range)	68 (37-76)	69 (45-79)	0.223
Sex			0.459
Male	10 (43.5%)	30 (54.5%)	
Female	13 (56.5%)	25 (45.5%)	
Body mass index, kg/m <sup>2</sup> (median, range)	22.5 (18-26.9)	24.2 (17.9-33.6)	<b>0.028</b>
American Society of Anesthesiologists physical status			0.910
Class I	22 (95.7%)	54 (98.2%)	
Class II	1 (4.3%)	1 (1.8%)	
Class III	2 (4.3%)	2 (1.8%)	
Class IV	3 (4.3%)	3 (1.8%)	
Previous abdominal surgical history (present)	11 (47.8%)	18 (32.7%)	0.304
Tumor location			<b>0.005</b>
Cecum	9 (39.1%)	5 (9.1%)	
Ascending colon	13 (56.5%)	41 (74.5%)	
Transverse colon	1 (4.3%)	9 (16.4%)	
cStage			0.099
I	14 (60.9%)	19 (34.5%)	
II	3 (13.0%)	11 (20.0%)	
III	6 (26.1%)	25 (45.5%)	
Mechanical bowel preparation (present)	21 (91.3%)	41 (74.5%)	0.128
Chemical bowel preparation (present)	17 (73.9%)	52 (94.5%)	<b>0.017</b>

Statistically significant p-values are shown in bold.

Table II. Comparison of intraoperative parameters between anti-peristaltic and iso-peristaltic anastomosis in right-sided colorectal surgery.

	Anti-peristaltic anastomosis n=23	Iso-peristaltic anastomosis n=55	p-Value
Type of surgery			<b>0.001</b>
Right hemicolectomy	14 (60.9%)	51 (92.7%)	
Right colectomy	9 (39.1%)	4 (7.3%)	
Lymph node dissection			0.268
D2	1 (4.3%)	8 (14.5%)	
D3	22 (95.7%)	47 (85.5%)	
Conversion (present)	0 (0%)	0 (0%)	-
Intraoperative complication (present)	0 (0%)	0 (0%)	-
Blood loss, ml (median, range)	0 (0-150)	0 (0-200)	0.278
Transfusion (present)	0 (0%)	0 (0%)	-
Operative time, min (median, range)			
Total	249 (117-354)	197 (109-444)	<b>0.017</b>
Time on console	167 (87-258)	157 (78-340)	0.319
Time for anastomosis*	33 (10-66)	29 (12-68)	0.380

\*Time from intestinal resection of both oral and anal side to completion of anastomosis. Statistically significant p-values are shown in bold.

frequently in the isoperistaltic anastomosis group (92.7%) than in the antiperistaltic anastomosis group (60.9%) ( $p=0.0014$ ). The extent of lymph node dissection was similar between the groups, and no conversion or

intraoperative complications were observed in either group. Blood loss was similar in both groups, and none of the patients required transfusion. The total operative time was significantly longer in the antiperistaltic anastomosis

Table III. Comparison of postoperative parameters between anti-peristaltic and iso-peristaltic anastomosis in right-sided colorectal surgery.

	Anti-peristaltic anastomosis n=23	Iso-peristaltic anastomosis n=55	p-Value
Days to the first flatus, day (median, range)	3 (1-4)	3 (1-6)	0.468
Postoperative complication			
Total	3 (13.0%)	7 (12.7%)	1
Anastomosis-related complications	1 (4.3%)	0 (0%)	-
Anastomotic leakage	0 (0%)	0 (0%)	-
Anastomotic stenosis	1 (4.3%)	0 (0%)	-
Anastomotic bleeding	0 (0%)	0 (0%)	-
Grade III or more	2 (8.7%)	1 (1.8%)	0.206
Anastomotic stenosis	1 (4.3%)	0 (0%)	-
Ileus	1 (4.3%)	0 (0%)	-
Common bile duct stone	0 (0%)	1 (1.8%)	-
Surgery-related mortality	0 (0%)	0 (0%)	-
Postoperative hospital stay, days (median, range)	7 (5-13)	6 (4-12)	<b>&lt;0.0001</b>
Re-admission within 30 days after operation	1 (4.3%)	1 (1.8%)	0.506

Statistically significant p-values are shown in bold.

group, while the time on the console and the time for anastomosis were comparable between the groups.

**Postoperative complications.** The postoperative course and surgical complications are summarized in Table III. The frequency of postoperative complications was similar between the groups, and, as for anastomosis-related complications, there were no cases of anastomotic leakage or bleeding in both groups. In the antiperistaltic anastomosis group, one patient developed anastomotic stenosis and was treated with endoscopic balloon dilatation. No surgery-related mortalities occurred in either group. The incidence of postoperative prolonged ileus and time to first flatus were similar between the two groups.

## Discussion

This is the first observational study to evaluate the short-term results of intracorporeal isoperistaltic and antiperistaltic anastomoses in RAS for right-sided colon cancer. This study revealed equivalent safety and postoperative bowel recovery rates for both isoperistaltic and antiperistaltic anastomoses.

IA has recently attracted attention because of its minimally invasive nature. Compared to conventional EA,

IA has the advantages of less postoperative wound pain, less risk of postoperative complications, and early recovery of intestinal peristalsis because of a smaller laparotomy wound since the intestine is not guided outside the peritoneal cavity (14, 20-23).

A meta-analysis from five observational cohort studies involving 585 participants has demonstrated that IA is superior to EA in RAS and CLS in terms of the early recovery of intestinal peristalsis (15). Although RAS is expected to facilitate IA due to its technical advantages, the preferred type of IA in RAS for colon cancer remains controversial. Anastomoses should be generally consistent with the physiology of the gastrointestinal tract. A side-to-side anastomosis can be performed in the direction of isoperistalsis or antiperistalsis at the two dissected ends. In 2005, Tewari *et al* proposed a new isoperistaltic stapled side-to-side anastomosis after right hemicolectomy instead of the common side-to-side antiperistaltic anastomosis and is now considered the most appropriate anatomical anastomotic configuration because it is consistent with the physiological flow of the intestinal contents. In contrast, antiperistaltic anastomosis has the potential to reduce the incidence of postoperative bowel obstruction because it may prevent mesenteric torsion, which is observed in isoperistaltic anastomosis (24).

Although several clinical trials have compared isoperistaltic and antiperistaltic anastomosis, no consensus has yet been reached regarding the preferred technique (16, 17, 25, 26). There are only two randomized controlled trials that have previously compared isoperistaltic and anti-peristaltic anastomosis. Matsuda *et al.* (16) compared stapled side-to-side ileocolic and colon-colon anastomoses in patients with colon cancer, and observed no significant differences between the two groups in anastomotic leakage, bleeding, or stricture incidence; however, excessive morbidity was detected in the isoperistaltic anastomosis group and the study was terminated. Their study had several limitations, such as small sample size, different types of anastomoses included in the analysis (both ileocolonic and colonic anastomoses), and the use of open surgery (OS) *versus* CLS.

The ISOVANTI study (17) investigated patients with colon cancer who underwent laparoscopic right hemicolectomy and ileocolic anastomosis with isoperistaltic or antiperistaltic anastomosis. In this study, no significant differences in the operative time, anastomosis time, or postoperative complication rates (37.0% for isoperistaltic anastomosis *vs.* 40.7% for antiperistaltic anastomosis) were observed. Furthermore, there was no difference in postoperative bowel obstruction or anastomotic leakage rates (3.7% *vs.* 5.56%); however, "the time to first flatus and defecation" were significantly reduced in the antiperistaltic anastomosis group than in the isoperistaltic anastomosis group. The aforementioned trials assessed open surgery *versus* CLS; however, no studies have compared the short-term results of intracorporeal isoperistaltic and antiperistaltic anastomoses in RAS for colon cancer.

The results of the present study showed comparable reconstruction time, blood loss, and very low rates of anastomosis-related complications in both groups (Table II and Table III), which suggest that both anastomoses are safe in RAS owing to the technical advantages of the robotic system. However, it may be important for surgeons to learn both reconstruction methods so that they can be flexibly used depending on the position of the intestinal

tract between the oral and anal sides. In this study, isoperistaltic anastomosis was selected more often in ascending and transverse colon cancer surgery, and was performed more often after right hemicolectomy, suggesting that isoperistaltic anastomosis was easier and selected more often when the distal colon used for anastomosis was closer to the middle or left side of the transverse colon. Isoperistaltic anastomosis reduces the extent of bowel mobilization and eliminates mobilization of the splenic flexure, making reconstruction simpler and easier. Some authors pointed out that antiperistaltic anastomosis needs greater intestinal flexibility than isoperistaltic anastomosis (16, 27).

*Our study has several limitations.* First, the relatively small sample size (78 patients) may have led to a Type II error, where a real difference in complication rates between the groups was not detected. To validate our findings of this study, a larger-scale, multicenter, randomized controlled trial is needed. Second, this was a retrospective observational study that used the database of a multicenter prospective study; hence, the necessary sample size to compare outcomes between isoperistaltic and antiperistaltic anastomoses was not calculated. Third, only the short-term results within 30 days after surgery were evaluated. The voiding function and quality of life in long-term cases were not evaluated. Furthermore, the surgeons in this study were experts with considerable experience in RAS for rectal cancer but had relatively limited experience with colon cancer. Although both anastomoses showed favorable outcomes in this study, there may have been surgeon bias. Further large-scale, multicenter, randomized studies are needed to confirm our findings.

## Conclusion

Our findings revealed equivalent safety and postoperative bowel recovery between intracorporeal isoperistaltic and antiperistaltic side-to-side anastomoses in RAS for right-sided colon cancer. It is important for surgeons to be

proficient in both reconstruction techniques to enable flexible decision-making based on intraoperative findings.

## Conflicts of Interest

The Authors have no conflicts of interest to declare.

## Authors' Contributions

Akio Shiomi: Conceptualization, analysis, methodology, and writing – original draft. Hitoshi Hino: Conceptualization, analysis, methodology, and writing – original draft. Hiroyasu Kagawa, Masayoshi Yasui, Kouichi Okuya, Junichiro Hiro, Mamoru Uemura, Shinichi Yamauchi, and Yusuke Kinugasa: Conceptualization, resources, supervision, writing, review, and editing. All Authors gave final approval for this version to be published.

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## Artificial Intelligence (AI) Disclosure

No AI tools, including large language models or machine learning software, were used in the preparation, analysis, or presentation of this manuscript.

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