



Comparison of the short-term outcomes between intracorporeal isoperistaltic and antiperistaltic totally stapled side-to-side anastomosis for right colectomy: A retrospective study on 214 consecutive patients



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ABSTRACT

Background: Totally laparoscopic right colectomy has been demonstrated to be safe and feasible. Two manners of anastomosis, namely, antiperistaltic and isoperistaltic stapled side-to-side anastomosis, have been described before. However, research concerning the influence of different peristaltic orientations on anastomosis is rare and, if there is, included relatively small cases without long-term outcomes. The aim of this study was to compare the short- and long-term outcomes of intracorporeal isoperistaltic side-to-side anastomosis and antiperistaltic side-to-side anastomosis for right colectomy.

Methods: We retrospectively reviewed 214 consecutive patients who underwent totally laparoscopic right colectomy from January 2017 to December 2020 at our medical center. Two modalities of anastomosis were used: isoperistaltic totally side-to-side anastomosis and antiperistaltic totally side-to-side anastomosis. Data on demographics, disease features, pathological characteristics, operative details, and short-term outcomes were collected and analyzed.

Results: We found that operative features such as operating time, intraoperative bleeding, length of resected intestine, number of harvested lymph nodes, and length of incision, as well as measures of postoperative recovery such as time to first flatus, time to first defecation, and length of stay, were statistically comparable between the 2 groups. The postoperative complication rate was also similar between the 2 groups. The median follow-up time was 35.6 months, and no differences were observed in the long-term outcomes.

Conclusion: Intracorporeal isoperistaltic side-to-side anastomosis can achieve short- and long-term outcomes similar to those of antiperistaltic side-to-side anastomosis. Both techniques are safe and feasible.

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BACKGROUND

Since laparoscopic-assisted colectomy was first reported by Jacobs in 1991 [1], this technique has been popularized worldwide. With changes in surgical concepts and technological improvements in surgical instrumentation, increasingly many surgeons have attempted a less traumatic technique: totally laparoscopic colectomy with intracorporeal anastomosis. To date, totally laparoscopic right colectomy (TLRC) has been proven to reduce trauma and speed up recovery without increasing morbidity or mortality compared to conventional laparoscopic-assisted right colectomy [2–7].

The complexity of intracorporeal ileocolic anastomosis has been described by several studies [8,9]. In contrast to left colectomy, sigmoid colectomy, or resection, TLRC cannot be performed with circular staplers, which makes intracorporeal ileocolic anastomosis more difficult than other procedures. Stapled side-to-side anastomosis is the most common method [2–8] due to its convenience, stability, independence of bowel diameter discrepancy, and large anastomotic caliber. According to previous studies, there are 2 main configurations for intracorporeal side-to-side anastomosis: isoperistaltic and antiperistaltic. The safety and feasibility of both techniques have been proven [2–8]. Some surgeons prefer isoperistaltic anastomosis because this configuration is in line with bowel movement direction and requires less mobilization of intestine to overlap [9], whereas some favor antiperistaltic anastomosis because the anastomotic site can act as like a functional pseudovalvular mechanism [27]. However, according to our experience, these 2 configurations do not have much difference and might achieve similar clinical outcomes.

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So this study was conducted to compare the short- and long-term outcomes of intracorporeal isoperistaltic stapled side-to-side anastomosis (SSSA) and antiperistaltic SSSA for TLRC.

METHODS

Patients. From January 2017 to December 2020, 214 consecutive patients who underwent TLRC in our medical center were reviewed. Four surgeons were included in this study. All of them were junior surgeons who performed at least 50 laparoscopic right colectomies with intracorporeal anastomosis before and overcame the learning curve. Selection of configuration was according to surgeon's preference, and the details were shown in Table S1. Patients were included if they underwent totally laparoscopic right colectomy with complete mesocolic excision. We excluded any patients with distant metastasis or multiple primary cancers. Those with severe organ dysfunction, such as severe cardiopulmonary disorders, were also excluded.

Data Collection. We retrospectively reviewed data on patient demographics, disease-related features, pathological characteristics, operative details, and short-term outcomes. Demographics and disease-related features included age, sex, preoperative carcinoembryonic antigen (CEA) level, tumor location, history of abdominal surgery, and body mass index (BMI). We considered a number of pathological characteristics, including tumor/node/metastasis (TNM) stage (according to the American Joint Committee on Cancer), tumor size, number of harvested lymph nodes, number of positive lymph nodes, and length of resected intestine. Operative characteristics included duration of surgery, estimated blood loss, length of skin incision, and rate of conversion to laparotomy. Short-term (30-day) outcomes included postoperative complications, time to first flatus, time to first defecation, and postoperative length of stay. Long-term outcomes included long-term complications, rate of relapse or metastasis, and disease-free survival.

Surgical Procedure. Preoperative mechanical bowel preparation was performed, and antibiotics were administered. The patient was placed in the modified lithotomy position. A 5-port technique was applied. The procedures before digestive reconstruction were the same as those of conventional laparoscopic right colectomy, and they were in compliance with the principle of complete mesocolic excision. After transection of the transverse colon and terminal ileum by endoscopic linear staplers, the specimen was placed in an aseptic bag (Fig 1, A). Then, the anastomosis was carried out. For isoperistaltic totally SSSA, both ends of the intestines were placed so that they overlapped by approximately 7 cm in the

opposite direction (Fig 1, B). An enterotomy was then performed on the antimesenteric side of the ileum (Fig 1, C), and a colostomy was performed on the colon approximately 7 cm distal to the staple line (Fig 1, D). Next, the 2 jaws of the stapler were inserted into the bowels (Fig 1, E); the stapler was fired and withdrawn, and an isoperistaltic SSSA was thus created. The common enterotomy was closed with 1 more linear stapler (Fig 1, F). For antiperistaltic ileocolic anastomosis, the terminal ileum and transverse colon were placed so that they overlapped by approximately 7 cm in the same direction (Fig 2, A). An enterotomy was then performed on the antimesenteric side of the ileum at the edge of the staple line. The anvil jaw of a stapler was then introduced into the ileum and held in place (Fig 2, B), and the same maneuver was repeated on the transverse colic side. Next, the cartridge jaw was inserted into the transverse colon (Fig 2, C); the stapler was fired and withdrawn, and an antiperistaltic SSSA was thus created. Finally, the common enterotomy was closed with another stapler (Fig 2, D). The resected specimen was extracted through a suprapubic Pfannenstiel incision.

Perioperative Management and Follow-Up. Perioperative management was the same for all cases. All patients received patient-controlled analgesia on the first and second postoperative days. Nonsteroidal anti-inflammatory drugs were administered as rescue analgesics. Evaluation of bowel recovery was based on the passage of flatus and stool. Patients were allowed to eat when their bowel motility recovered. Patients who had no symptoms, tolerated 3 meals a day, and passed stool were approved for discharge. We performed follow-up phone calls on the 30th day after discharge. Clavien–Dindo classification was used to evaluate the adverse events. Grade I is defined as any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are drugs such as antiemetics, antipyretics, analgetics, diuretics, and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside. Grade II is defined as requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included. Grade III is defined as requiring surgical, endoscopic, or radiological intervention. Grade IV is defined as life-threatening complication (including central nervous system complications) requiring IC/ICU management. Grade V is defined as death of a patient. Adverse events that occurred within 30 days after the surgery were regarded as complications.

All the patients underwent assessment of serum CEA levels and CT imaging every 3 months for the first 2 years after surgery and biannually

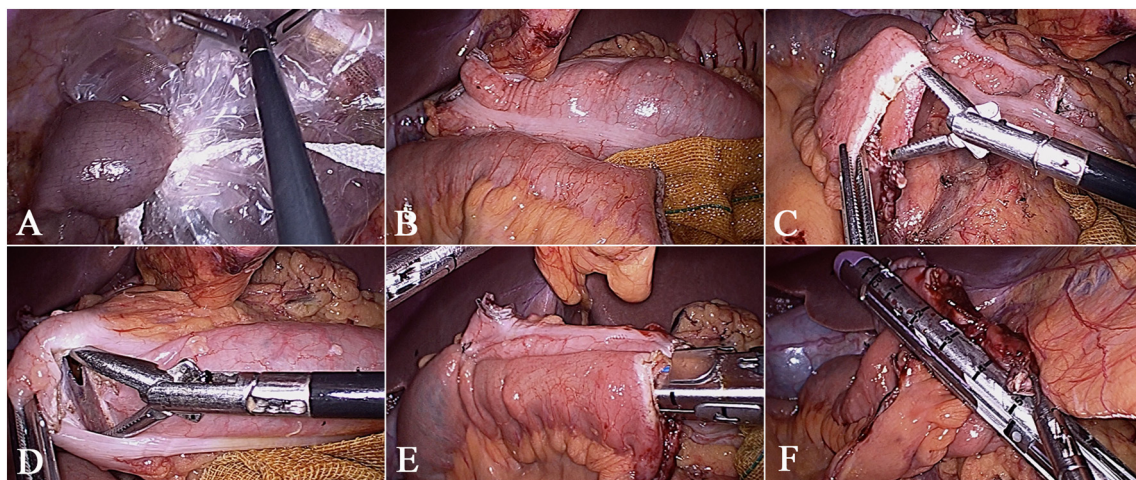


Fig 1. Procedures of isoperistaltic SSSA. The specimen was placed into a sterile bag (A). The terminal ileum and the transverse colon were placed overlapped in the opposite direction (B). An enterotomy was made on the antimesenteric side of ileum, and a colostomy was made on the colon about 7 cm distal to the staple line (C and D). Two jaws of the stapler were inserted into the intestine, respectively. The stapler was fired and withdrawn (E). The common enterotomy was closed by a linear stapler (F).

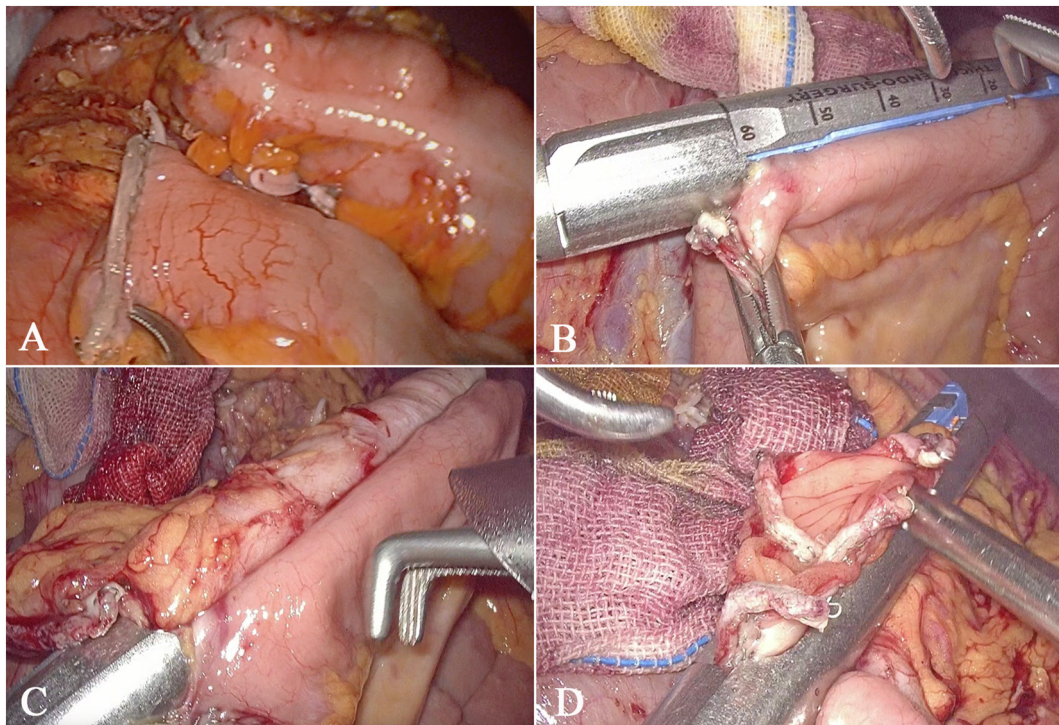


Fig 2. Procedures of antiperistaltic SSSA. The terminal ileum and transverse colon were placed overlapped in the same direction (A). An enterotomy was made on the antimesenteric side of ileum at the edge of staple line, and the anvil jaw of the stapler was introduced into the ileum (B). The cartridge jaw was inserted into the transverse colon after the colostomy was performed on the transverse colon. The stapler was fired and withdrawn (C). The common enterotomy was closed with another firing of stapler (D).

for the following 3 years. Colonoscopic examination was performed at 1-year intervals. Patients of stage III and stage II with a high risk of recurrence factor would accept adjuvant. Recurrence was defined as the appearance of new tumor in the location of the surgical area, regional nodes, incision, or the appearance of metastases in distant organs (lung, liver, brain, etc) or in peritoneum.

Statistical Analysis. Continuous variables with normal distribution were expressed as the mean \pm standard deviation and were analyzed with Student *t* test. Continuous variables with non-normal distribution were expressed as the median and range (min–max values) and were analyzed with Mann–Whitney *U* test. Categorical variables were expressed as percentages and were analyzed with Fisher exact test or a χ^2 test, as appropriate. Survival data were analyzed using the Kaplan–Meier method and compared with the log-rank test. SPSS software version 25.0.0 (SPSS Inc, Chicago, IL) was used for all statistical analyses.

This work was reported in line with the STROCSS criteria [10].

Table 1
Demographics and disease-related characteristics

	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
Sex			.16
Male	43 (43.4%)	61 (53.0%)	
Female	56 (56.6%)	54 (47.0%)	
Age	59.4 \pm 12.2	60.4 \pm 11.4	.53
BMI (kg/m ²)	24.0 \pm 3.6	24.1 \pm 3.3	.78
CEA (ng/mL)	3.0 (0.2–120.8)	2.9 (0.7–99.1)	.88
Localization of tumor			.71
Cecum	30 (30.3%)	35 (35.7%)	
Ascending colon	46 (46.5%)	44 (42.6%)	
Hepatic flexure	23 (23.2%)	22 (21.7%)	
Abdominal surgery history	17 (17.2%)	26 (22.6%)	.32

RESULTS

No significant differences were detected in terms of sex, age, BMI, preoperative CEA, tumor site, or abdominal surgery history, as shown in Table 1.

The operative characteristics are given in Table 2. Although the antiperistaltic group had a numerically longer duration of surgery than the isoperistaltic group, there was no significant difference (150.0 [88.0–276.0] vs 148.0 [91.0–264.0] minutes, $P = .41$). Intraoperative bleeding (25.0 [5.0–100.0] vs 25.0 [10.0–200.0] mL, $P = .99$) and length of incision (5.0 [4.0–10.0] vs 5.0 [4.0–8.0] cm, $P = .10$) were similar between the 2 groups. There was 1 case of conversion to open surgery in each group: 1 for severe abdominal adhesion and another for intraoperative hemorrhage.

Table 3 shows the pathological characteristics of the patients. There was no significant difference in the TNM stage ($P = .36$), tumor size (4.5 [1.0–9.5] vs 4.0 [1.5–11.0] cm, $P = .90$), number of harvested lymph nodes (33.0 [14.0–72.0] vs 36.0 [11.0–74.0], $P = .58$), number of positive lymph nodes (0.0 [0.0–40.0] vs 0.0 [0.0–16.0], $P = .98$), or length of resected intestine (36.0 [17.0–69.0] vs 38.0 [13.0–68.0] cm, $P = .85$) between groups.

The short-term outcomes are summarized in Table 4. In the antiperistaltic group, one patient underwent reoperation because of anastomotic leakage. In the isoperistaltic group, 1 case of anastomotic

Table 2
Operative characteristics

	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
Operative time (min)	150.0 (88.0–276.0)	148.0 (91.0–264.0)	.41
Estimated blood loss (mL)	25.0 (5.0–100.0)	25.0 (10.0–200.0)	.99
Length of incision (cm)	5.0 (4.0–10.0)	5.0 (4.0–8.0)	.10
Conversion to laparotomy	1 (1.0%)	1 (0.9%)	1.00

Table 3
Pathological characteristics

	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
TNM stage			.36
I	17 (17.2%)	29 (25.2%)	
II	40 (40.4%)	41 (35.7%)	
III	42 (42.4%)	45 (39.1%)	
Tumor size	4.5 (1.0–9.5)	4.0 (1.5–11.0)	.90
Harvested lymph nodes	33.0 (14.0–72.0)	36.0 (11.0–74.0)	.58
Positive lymph nodes	0.0 (0.0–40.0)	0.0 (0.0–16.0)	.98
Length of resected intestine (cm)	36.0 (17.0–69.0)	38.0 (13.0–68.0)	.85

leakage and 1 case of postoperative intra-abdominal hemorrhage were recorded, resulting in reoperation. No intergroup difference was observed in rescue analgesic usage (6.1% vs 7.0%, $P = .80$), time to first flatus (3.0 [1.0–4.0] vs 2.0 [1.0–5.0] days, $P = .52$), time to first defecation (3.0 [2.0–6.0] vs 3.0 [2.0–5.0] days, $P = .67$), or postoperative length of stay (6.0 [3.0–12.0] vs 6.0 [3.0–15.0] days, $P = .10$).

All postoperative complications according to the Clavien–Dindo classification system are summarized in Table 5. There were 21 (21.2%) adverse events in 1 group and 26 (22.6%) in the other. In the antiperistaltic group, the incidence rates of grade I–II and grade III–IV complications were 14.1% and 6.1%, respectively. In the isoperistaltic group, the rates of grade I–II and grade III–IV complications were 15.7% and 6.1%, respectively. No patient died in either group. We did not observe a significant difference between the 2 groups with regard to the total number of complications ($P = .81$) or the number of grade III–IV complications ($P = .99$).

Long-term outcomes were shown in Table 6. The median follow-up time was 35.3 months in antiperistaltic group and 35.6 months in isoperistaltic group. Rates of long-term complications and relapse or metastasis were comparable between 2 groups. No difference was observed in disease-free survival (Fig 4).

DISCUSSION

The importance of anastomosis cannot be overemphasized in colorectal surgery. A good anastomosis can improve postoperative recovery and quality of life. Although various anastomotic methods have been described, such as end-to-end, end-to-side, or side-to-side configurations with stapled or handsewn junctions, the most ideal method is still disputed. Handsewn end-to-end anastomosis is a standard procedure for reconstructing intestinal continuity, but it presents problems such as stenosis and diameter discrepancy, especially for ileocolic anastomosis and prolonging operative time [11,12]. After the introduction of stapling devices, mechanical anastomosis became popular worldwide because of its convenience and stability. Some studies have also shown that ileocolic stapled anastomosis is safer than handsewn anastomosis [13,14].

Intracorporeal ileocolic anastomosis was first carried out in 1991 [15] and first reported in detail in 2003 by Casciola [16]. With regard to anastomotic techniques, side-to-side anastomosis is always recommended [2–7,15–26]. Intracorporeal anastomoses can be designed with an isoperistaltic or antiperistaltic orientation. Surgeons who favor

Table 4
Short-term outcome

	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
Rescue analgesic usage	6 (6.1%)	8 (7.0%)	.80
Reoperation	1 (1.0%)	2 (1.7%)	1.00
Time to first flatus (d)	3.0 (1.0–4.0)	2.0 (1.0–5.0)	.52
Time to first defecation (d)	3.0 (2.0–6.0)	3.0 (2.0–5.0)	.67
Length of stay (d)	6.0 (3.0–12.0)	6.0 (3.0–15.0)	.10
Readmission	0 (0%)	0 (0%)	

Table 5
Complications according to Clavien–Dindo classification

Grade	Complication	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
Grade I	Pain	6	8	
	Fever	3	4	
	Wound infection	1	2	
	Nausea & vomit	4	4	
		1 (1.0%)	1 (0.9%)	
Grade II	Blood transfusion	1	1	
		3 (3.0%)	4 (3.5%)	
Grade IIIa	Abdominal infection	1	1	
	Ileus	2	3	
Grade IIIb		1 (1.0%)	2 (1.7%)	
	Anastomotic leakage	1	1	
Grade IIIc	Bleeding	0	1	
		2 (2.0%)	1 (0.9%)	
Grade IV	ICU management	2	1	
	Mortality	0 (0%)	0 (0%)	
Number of grade III–IV complications		6 (6.1%)	7 (6.1%)	.99
Total number of complications		21 (21.2%)	26 (22.6%)	.81

the former option believe that this configuration is consistent with bowel movement direction and has advantages in other sites, such as the esophagus, stomach, and hepatobiliary tract [27]. Those who prefer the latter option believe that isoperistaltic ileocolic anastomosis leads to a certain degree of "twisting" of the terminal ileum mesentery, while the antiperistaltic configuration does not. Therefore, antiperistaltic configuration could reduce postoperative ileus [28]. Moreover, the antiperistaltic anastomosis could act as a functional pseudovalvular mechanism to diminish ileocecal reflux and postoperative ileus [29].

There have been only 2 studies comparing the 2 anastomotic configurations. One was reported in 2015 by Akihisa Matsuda [9]. The study was suspended because excessive morbidity was detected in the isoperistaltic SSSA group. In conclusion, that study did not show any advantages or disadvantages of isoperistaltic SSSA compared with antiperistaltic SSSA. However, the study had obvious limitations: the sample size was relatively small, and there were some confounding factors, such as various tumor locations and different numbers of additional handsewn sutures for anastomotic reinforcement. Another study was reported in 2019 by Noelia Ibáñez [29]. The perioperative and short-term outcomes in the present study were almost the same as those in Ibáñez's study, except for postoperative bowel recovery. Ibáñez found that patients in the isoperistaltic group had longer intervals to first flatus and defecation, whereas such differences were not observed in our study. In addition, our study did not find difference in long-term complications, rate of recurrence, and disease-free survival. Ibáñez's study was a prospective randomized controlled one but with relatively small sample size, and long-term follow-up was lacking. Our study is limited by its retrospective nature. However, we included more cases with long-term outcomes. So far, among the researches that compare the short- and long-term outcomes between antiperistaltic and isoperistaltic anastomosis, the sample size in our study is the largest. Our study further confirmed that these 2 anastomotic configurations could achieve similar oncological outcome.

Previous studies showed that antiperistaltic SSSA required more intestinal mobilization than isoperistaltic SSSA and thus might prolong

Table 6
Follow-up outcomes

	Antiperistaltic (n = 99)	Isoperistaltic (n = 115)	P value
Incisional herniation	2 (2.0%)	2 (1.7%)	1.00
Bowel obstruction	3 (3.0%)	4 (3.5%)	1.00
Chronic diarrhea*	28 (28.3%)	29 (25.2%)	.61
Relapse or metastasis	12 (12.1%)	16 (13.9%)	.70

* More than 3 stools per day 1 year after surgery.

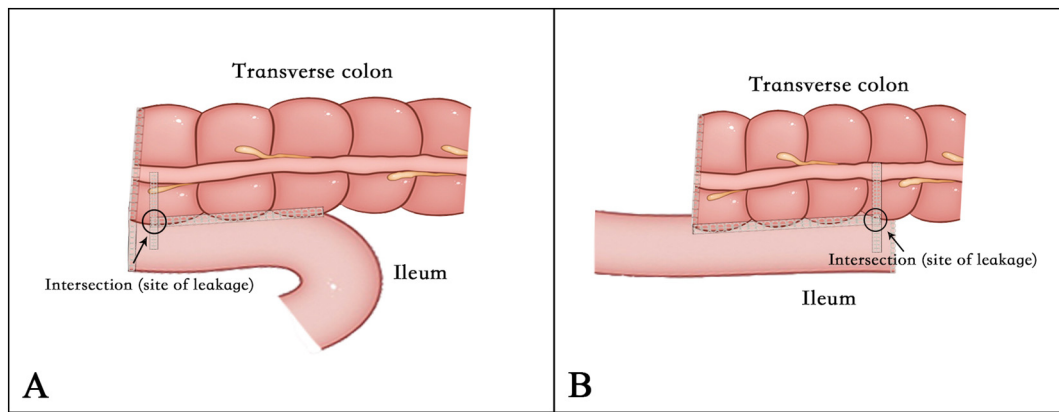


Fig 3. Schematic diagram for the site of anastomotic leakage. Antiperistaltic SSSA (A) and isoperistaltic SSSA (B). The site of anastomotic leakage was at the intersection of 2 staple lines—one was created by anastomotic stapler, and the other was created by closing the common enterotomy.

the operating time and increase the risks of hemorrhage [9]. In the present study, the 2 groups showed comparable intraoperative times and intraoperative bleeding. From the perspective of anatomy, intestinal mesentery is relatively long, and its mobility will be enough to perform antiperistaltic SSSA. On the technical side, unlike extracorporeal anastomosis, intracorporeal anastomosis does not require exteriorization of the intestine. Therefore, it is not necessary to mobilize the large intestine for intracorporeal antiperistaltic SSSA.

In terms of postoperative complications, the incidence of anastomotic leakage was relatively low, with only one occurrence in each group, both resulting in reoperation. Intraoperative findings demonstrated that the site of anastomotic leakage was at the intersection of 2 staple lines (one was created by the anastomotic stapler, and the other was created by closing the common enterotomy, as shown in Fig. 3). Therefore, additional hand suturing was recommended for reinforcement at the intersection. Another finding was that the incidence of postoperative ileus was similar between the 1 groups (2.0% for antiperistaltic vs 2.6% for isoperistaltic), which was inconsistent with the theory that twisting of the ileum mesentery in isoperistaltic SSSA increases the risk of postoperative ileus. We speculate that full visualization of the mesoileum during intracorporeal anastomosis could help avoid mesenteric torsion and twisting. The similar rates of overall and severe (grade III–IV) complications indicate that these 2 anastomotic modalities are equally safe.

Several limitations of this study should be considered. First, this was a retrospective study, and the patients were not grouped randomly.

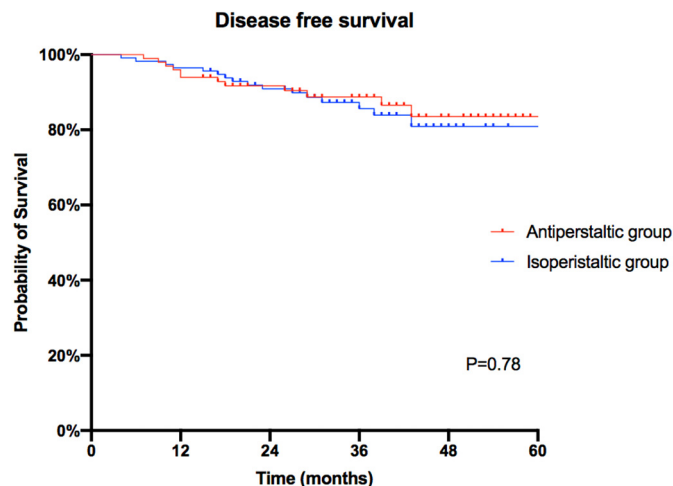


Fig 4. Kaplan–Meier survival probability curve for antiperistaltic and isoperistaltic anastomosis.

Recall and selection biases are definitely present. Our conclusion needs to be further confirmed by randomized controlled trials. Second, we applied traditional perioperative management instead of the ERAS protocol for all the patients in this study. Consequently, the parameters of time to recovery were slightly longer in this study than in those that applied the ERAS protocol.

In conclusion, for laparoscopic right colectomy, intracorporeal isoperistaltic totally SSSA achieved a similar short-term outcome to antiperistaltic totally SSSA. Both modalities are safe and feasible.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sopen.2022.03.006>.

Disclosures

Author Contribution. Conception and design: XSW and MGZ; administrative support: XSW, HTZ, and ZXZ; provision of study materials or patients: XSW, HTZ, ZL (Zheng Liu), and ZXZ; collection and assembly of data: MGZ and ZL (Zhao Lu); data analysis and interpretation: MGZ, XYH, and ZL; manuscript written: MGZ; manuscript revision: MGZ, ZL (Zhao Lu), ZL (Zheng Liu), XYH, ZXZ, HTZ, and XSW.

Conflict of Interest

No authors have conflicts of interest or financial ties to disclose.

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Availability of Data and Material

All the clinical data were collected from electronic records system of Cancer Hospital Chinese Academy of Medical Sciences.

Ethics Approval

There is no potential conflict of interest. This study involved human participants and was approved by Ethics Committee of National Cancer Center/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College. The reference number is NCC201803009. This study complies with the Declaration of Helsinki. All the participated patients signed informed consent.

Consent to Participate

All the patients were informed during the follow-up, and they agreed to join this research.

Consent for Publication

Written informed consent for publication was obtained from all participants.

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