Intracorporeal versus extracorporeal anastomosis in laparoscopic right colectomy: a retrospective study

Fangqian Chen
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Zeping Lv
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Wenqing Feng
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Zhuoqing Xu
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Yiming Miao
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Zifeng Xu
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Yuchen Zhang
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Han Gao
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Minhua Zheng
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Yaping Zong
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Jingkun Zhao (zhaojk8891@126.com)
Ruijin Hospital, Shanghai Jiaotong University School of Medicine
Aiguo Lu
Ruijin Hospital, Shanghai Jiaotong University School of Medicine

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Abstract

Background: Laparoscopic right colectomy (LRC) with intracorporeal ileocolic anastomosis (IIA) may be beneficial for postoperative recovery, but there is a lack of evidence to confirm this hypothesis. This study aimed to investigate the feasibility and safety of IIA.

Methods: A total of 114 patients who underwent LRC with IIA (58) or extracorporeal ileocolic anastomosis (EIA, 56) between January 2019 and September 2021 were enrolled. We assessed clinical characteristics, pathological characteristics and short-term outcomes.

Results: Faster gastrointestinal (GI) recovery and less postoperative pain were observed in patients with IIA than EIA [time to first flatus: (2.4±0.7) vs (2.8±1.0) days, p <0.01; time to fluid intake: (3.5±0.7) vs (4.0±1.1) days, p =0.01; visual analogue scale score on the day of surgery: (3.9±1.0) vs (4.3±0.6), p =0.02]. No significant differences were detected in oncological outcomes or postoperative complications. IIA tended to be performed in patients with higher body mass index than EIA [(23.93±3.52) vs (22.36±2.87) kg/m^2, p =0.01].

Conclusions: IIA is associated with faster GI function recovery and less postoperative pain, and considered to be potentially superior to EIA in patients with obesity.

Introduction

Colectomy is the primary treatment of for non-metastatic colon cancer (CC)[1]. Since Jacobs first reported laparoscopically-assisted colectomy (LAC) in 1991, surgical techniques for LAC have developed rapidly around the world. LAC has statistically and clinically significant advantages over open surgery with respect to intraoperative blood loss, postoperative pain, the recovery of gastrointestinal (GI) function and the length of hospital stay (LOHS), while maintaining similar long-term survival[2–4]. Laparoscopic right colectomy (LRC) has become a well-standardized surgical procedure for right CC, adopted by surgeons worldwide[1,5,6]. At present, LRC in clinical practice can be divided into laparoscopic assisted right colectomy (LARC) and total laparoscopic right colectomy (TLRC), according to the method of reconstruction of the digestive tract continuity. The initial steps are similar in the two surgical methods, but subsequently extracorporeal ileocolic anastomosis (EIA) is performed in LARC, and intracorporeal ileocolic anastomosis (IIA) is performed in TLRC. It is more difficult for surgeons to perform TLRC than LARC due to the technical complexity. Some studies have been published that compare LRC with IIA versus EIA, indicating that TLRC may be associated with faster GI recovery and less postoperative pain[7–9].but there is still a lack of a definite conclusion. The aim of this study was to investigate the feasibility and safety of LRC with IIA.

Methods

Patients

A total of 114 consecutive patients who were admitted to the minimally invasive surgery center of Ruijin Hospital affiliated to Shanghai Jiao Tong University, School of Medicine, Shanghai, China, from January 2019 and September 2021, due to a benign or malignant right-sided colon neoplasm, and who received LRC were included.

The exclusion criteria were: (1) age ≤ 18 or > 75 years old; (2) distant metastases; (3) emergency surgery for acute abdominal complications (including acute bowel obstruction and perforation); (4) combination with severe primary diseases such as cardiovascular, kidney, lung or hematopoietic system, or mental illnesses leading to high perioperative risk; (5) post-neoadjuvant therapy; and (6) synchronous transection of more than one intestinal segment. All LRC was primarily performed by one surgeon, who was fully trained in colorectal surgery and laparoscopic surgery.

Surgical Technique

Patients underwent TLRC or LARC depending on the surgeon's previous individual experience and clinical considerations. The surgeon had previously performed at least 200 laparoscopic surgeries for right CC at our institution.

The preparation for surgery, patient position, surgeon location, and insertion of trocars were the same as previously reported[10]. For cases of clinical consideration of malignant tumors, the mesentery and vessels were dissected and separated in the same manner in the two groups, complying with the principle of laparoscopic complete mesocolic excision.

The method of transection and anastomosis varied according to the procedure selected (TLRC or LARC). Key steps for IIA and EIA are:

• IIA group (Fig. 1): (1) dissociation of the mesentery in the abdominal cavity; (2) transection of terminal ileum and transverse colon using a linear stapler; (3) overlap anastomosis using a linear stapler; (4) enterotomy closure using a barbed suture;

• EIA group (Fig. 2) : (1) dissociation of the mesentery in the abdominal cavity; (2) bowel extraction through an enlargement of the skin incision in the paraumbilical position; transection of terminal ileum and transverse colon; (3) side-to-side anastomosis using a linear cutter; (4) enterotomy closure using the linear cutter; (5) anastomosis reinforcement using 3 – 0 Vicryl interrupted suture.

Statistical analysis

Categorical data are presented as absolute numbers and percentages, whereas continuous variables are presented as means ± standard deviations (SDs). The Pearson's chi-squared test was used for the comparison of qualitative variables and Student's t test for the analysis of quantitative variables. All *p* values were obtained using the 2-sided exact method, at the conventional 5% significance level. The statistical analyses were performed using SPSS Statistics 22.0.

Results

A total of 114 consecutive patients were included in the study. Fifty-eight patients (26 males and 32 females) diagnosed with benign or malignant neoplasm underwent LRC with IIA. There were 14, 31, and 13 patients diagnosed with tumors of the cecum, ascending colon, and hepatic flexure, respectively. There were 8 benign cases and 50 malignant cases. The mean age of patients was (61 ± 11) years and the mean body mass index (BMI) was (23.93 ± 3.52) kg/m^2. The preoperative hemoglobin and albumin levels were (122.1 ± 23.8) g/L and (40.2 ± 4.3) g/L, respectively. No significant differences were detected in terms of gender, age, hemoglobin level, albumin level or pathological outcome between the IIA and EIA groups. Higher BMI was observed in the IIA group (Table 1).

For the intraoperative results in the IIA group, the average operative time was (130 ± 32) min and the average blood loss was (60 ± 57) mL. and there was no difference between the IIA and EIA groups (Table 2). There were no intraoperative complications, such as ureter injury, gastrointestinal damage, and subcutaneous emphysema.

Oncologic outcomes of malignant cases were analyzed. For the quality of specimens in the IIA group, the number of lymph nodes harvested was (21 ± 10), the average proximal margin distance was (12.2 ± 7.9) cm and the average distal margin distance was (10.3 ± 5.2) cm. The oncological outcomes were comparable in the IIA and EIA groups (Table 3).

Postoperative results are shown in Table 4. Patients in the IIA group showed a quicker recovery of GI function and less postoperative pain than the EIA group. The average time to flatus of patients undergoing an IIA was (2.4 ± 0.7) days ($p < 0.01$) and the time to fluid intake was (3.5 ± 0.8) days ($p = 0.01$). Lower visual analogue scale (VAS) score was detected in the IIA group, especially on the day of surgery (3.9 ± 1.0, $p = 0.02$). No significant difference was found in LOHS between the two groups. Postoperative complications were graded according to the Clavien-Dindo classification. There was a case of anastomotic bleeding recorded in the EIA group. The patient received blood transfusion without invasive intervention, and was finally discharged on postoperative day (POD) 12. There were no cases of anastomotic leak (the incidence of anastomosis-related complications was < 2% at our institution[11]). Other postoperative complications were recorded in detail. There was one case of bowel obstruction, a case of pneumonia and a case of wound infection in the IIA group. There was a case of chyme leak and a case of delayed recovery of GI function in the EIA group. The five cases of complications were Clavien-Dindo grades I–II and no grade III–IV complications occurred in our study. There was no significant difference in morbidity rates during hospitalization between the two groups.

The average hospitalization expenses of patients in the IIA group were (7322 ± 1137) USD, significantly more than those of the EIA group (Table 4).

Due to the higher BMI of the IIA group, we completed a subgroup analysis of patients with BMI ≥ 24 kg/m^2 (Table 5). There was no significant difference in clinical characteristics and morbidity rates between the two groups.

Discussion

For LRC, surgical procedures involving anastomosis (IIA or EIA) are still under debate. A growing number of studies[7,8,12] have indicated that both of these surgical procedures are pathologically equivalent and have similar long-term outcomes, including overall survival, disease-free survival, and the rate of peritoneal recurrence. IIA was even found to achieve a more precise tumor excision than EIA[12]. Some studies[9,12–15] and meta-analyses [16,17] show that patients undergoing IIA may show a faster recovery of GI function, less postoperative pain, lower surgical stress response (SSR), fewer medical complications and shorter LOHS. In line with these studies, our study now provides evidence for the safety and effectiveness of IIA.

No significant differences were detected in operative time, intraoperative blood loss, oncological outcomes, overall morbidity rates or LOHS. Our findings were in concordance with the RCT of Allaix [8]. Due to the wide and clear field of view in TLRC, operations go smoothly and anastomosis twists can be avoided. Furthermore, with the invention and application of advanced laparoscopic linear staplers, IIA has become simpler and more efficient. Although IIA poses greater technical difficulty and requires advanced technical skills in laparoscopic surgery, we believe that after a period of practice, the safety of the surgery can be guaranteed without increasing operative time.

Previously published studies paid little attention to costs for hospitalization. In our study, we found that patients in the IIA group paid more for hospitalization than the EIA group, but patients had a high degree of acceptance regarding this. This difference could be explained by the different equipment used in the surgery. During TLRC, one linear stapler and three surgical staples were used in order to perform transection of the bowels and overlap anastomosis. In contrast, EIA could be completed using one linear cutter and two surgical staples. We believe that with the popularization of the equipment and the advancement of medical care, equipment costs can be reduced.

GI function recovered earlier in patients in the IIA group, particularly in terms of first flatus ($p < 0.01$). The time of first stool passage did not show a significant difference in our study ($p = 0.22$), but the mean time was shorter in the IIA group. Meanwhile, tolerance of a soft diet occurred earlier in patients undergoing IIA ($p < 0.01$). This result can be explained by the reduced surgical injury in IIA procedures. Owing to less exteriorization and dissection of bowel and mesocolon in IIA, TLRC was thought to have a smaller effect on GI motility.

Patients with an IIA suffered less postoperative pain, particularly on the day of surgery. The benefit of IIA over EIA in reducing postoperative pain may be associated with a shorter skin incision for extracting the specimen. Data on the length of skin incision was not recorded in our hospital's electronic database, but this has been confirmed in some other studies[9].

As already known, sufficient bowel and mesentery exteriorization must be completed so that the bowel can be pulled out of the body in EIA, which may increase the probability of bleeding and cause additional

damage to the tissue (Fig. 3). It is more difficult for surgeons to perform EIA in patients with obesity because of the presence of thick and short mesentery. It was hypothesized that IIA could decrease the incision length, reduce conversion rate and eliminate the need for bowel exteriorization for anastomosis, so it may be particularly beneficial for patients with obesity[18,19]. This may explain why our medical team tended to adopt IIA for patients with higher BMI. A case-matched study[20] has concluded that IIA in patients with obesity (BMI > 30kg/m^2) was associated with similar short-term outcomes and lower incidence of incisional hernias, and may possibly reduce the risk of hospital readmission. However, some published studies[21–24] show that obesity is associated with postoperative complications, anastomotic leakage and re-operation. A negative influence of visceral fat on lymph nodes harvested was observed in patients with colorectal cancer[22]. In our subgroup analysis of patients with BMI ≥ 24 kg/m^2, there was no significant difference found in rate or severity of postoperative complications in the two groups. Besides, the oncological outcomes in the IIA group were similar to those in the EIA group. Based on the potential advantages of lower surgical difficulty and reduced intraoperative risk, we believe that IIA may be a better approach for LRC in patients with obesity.

This study has some limitations. First, the study was limited by its retrospective, single-institution and single-surgeon nature. Second, the data on postoperative complications included only those during hospitalization, but not the mid- and long-term follow-up outcomes, such as incisional hernia, survival and recurrence after discharge. Third, the faster recovery of GI function and lower postoperative pain did not lead to a decrease in LOHS. Significant difference in LOHS may be reached within an enhanced recovery (ERAS) program, which we will consider adopting in a subsequent RCT. Lastly, the low incidence of postoperative complications may mean that this study was underpowered to identify statistical differences. In order to mitigate these drawbacks, we have designed an RCT and are enrolling patients. The study was registered with the Chinese Clinical Trials Registry (ChiCTR2100053282). All patients provided written informed consent before enrollment. The study protocol was approved by the Ruijin Hospital Ethics Committee (Shanghai Jiao Tong University School of Medicine).

Conclusions

LRC with IIA may be associated with faster GI function recovery and less postoperative pain, with comparable oncological outcomes compared to EIA. IIA is considered to be potentially superior to EIA in patients with obesity.

Abbreviations

BMI, body mass index; CC, colon cancer; EIA, extracorporeal ileocolic anastomosis; ERAS, enhanced recovery after surgery; GI, gastrointestinal; IIA, intracorporeal ileocolic anastomosis; LAC, laparoscopically-assisted colectomy; LARC, laparoscopic assisted right colectomy; LOHS, length of hospital stay; LRC, laparoscopic right colectomy; POD, postoperative day; SD, standard deviations; SSR, surgical stress response; TLRC, total laparoscopic right colectomy; VAS, visual analogue scale score

Declarations

Ethics approval and consent to participate

The study was registered with the Chinese Clinical Trials Registry (ChiCTR2100053282).

Availability of data and materials

The data that support the findings of this study are available from Department of General Surgery, Ruijin Hospital, Shanghai Jiaotong University School of Medicine but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Department of General Surgery, Ruijin Hospital, Shanghai Jiaotong University School of Medicine.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Chen FQ and Lv ZP contributed equally to this study; Chen FQ, Lv ZP, Zong YP, Zhao JK and Lu AG designed the research; Feng WQ, Xu ZQ and Miao YM collected the data and prepared the manuscript; Chen FQ, Lv ZP, Xu ZF, Zhang YC and Gao H wrote the manuscript; Zheng MH helped design the study with constructive discussions; All authors have read and approved the final manuscript.

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Tables

Table 1
Patients' characteristics

	IIA (n = 58)	EIA (n = 56)	*p* value
Gender			0.35
Male, N (%)	26 (44.8)	30 (53.6)	
Female, N (%)	32 (55.2)	26 (46.4)	
Age (yr)	61 ± 11	62 ± 11	0.48
BMI (kg/m^2)	23.93 ± 3.52	22.36 ± 2.87	0.01
Hb (g/L)	122.1 ± 23.8	117.1 ± 22.7	0.26
Ab (g/L)	40.2 ± 4.3	38.9 ± 4.8	0.12
Tumor type, N (%)			0.94
Benign	8 (13.8)	10 (17.9)	
Malignant	50 (86.2)	46 (82.1)	
Tumor site, N (%)			0.91
Cecum	14 (24.1)	13 (23.2)	
Ascending colon	31 (53.4)	32 (57.1)	
Hepatic flexure	13 (22.5)	11 (19.7)	
Tumor staging, N (%)			0.06
I	17 (34.0)	6 (13.0)	
II	19 (38.0)	24 (52.2)	
III	14 (28.0)	16 (34.8)	

Table 2
Intraoperative results

	IIA (n = 58)	EIA (n = 56)	*p* value
Operative time, min	130 ± 32	125 ± 29	0.34
Intraoperative blood loss, mL	60 ± 57	71 ± 66	0.35
No significant difference was found.			

Table 3
Oncological outcomes of malignant cases

	IIA (n = 50)	EIA (n = 46)	*p* value
Number of lymph nodes harvested	21 ± 10	21 ± 6	0.97
Margin distance, cm			
Proximal	12.2 ± 7.9	10.4 ± 5.1	0.18
Distal	10.3 ± 5.2	10.5 ± 5.4	0.87
No significant difference was found.			

Table 4
Postoperative results

	IIA (n = 58)	EIA (n = 56)	*p* value
Return of GI function, days			
Gas	2.4 ± 0.7	2.8 ± 1	<0.01
Stool	3.8 ± 1.5	4.2 ± 1.8	0.22
Time to fluid intake, days	3.5 ± 0.8	4.0 ± 1.1	0.01
VAS score			
The day for surgery	3.9 ± 1.0	4.3 ± 0.6	0.02
POD 1	3.2 ± 1.1	3.5 ± 0.7	0.08
LOHS, days	6.9 ± 2.9	7.0 ± 1.6	0.84
Anastomosis-related complication, N (%)			0.31
Anastomotic bleeding	0	1 (1.8)	
Anastomotic leak	-	-	
Type of other complication, N (%)			0.68
Bowel obstruction	1 (1.7)	-	
Delayed recovery of GI function	-	1 (1.8)	
Chyme leak	-	1 (1.8)	
Pneumonia	1 (1.7)	-	
Wound infection	1 (1.7)	-	
Hospitalization expenses, USD $	7322 ± 1137	5643 ± 896	<0.01

POD, postoperative day

USD $, US Dollar

Table 5
Subgroup analysis of patients with BMI ≥ 24 kg/m^2

	IIA (n = 29)	EIA (n = 15)	*p* value
Gender			0.07
Male, N (%)	15 (51.7)	12 (80.0)	
Female, N (%)	14 (48.3)	3 (20.0)	
Age (y)	61 ± 10	60 ± 10	0.74
BMI (kg/m^2)	26.61 ± 2.48	25.96 ± 1.85	0.38
Hb (g/L)	124.1 ± 26.7	128.7 ± 20.4	0.56
Ab (g/L)	40.1 ± 3.9	39.9 ± 4.3	0.88
Tumor type, N (%)			0.46
Benign	5 (17.2)	4 (26.7)	
Malignant	24 (82.8)	11 (73.3)	
Tumor site, N (%)			0.73
Cecum	7 (24.1)	4 (26.7)	
Ascending colon	13 (44.8)	8 (53.3)	
Hepatic flexure	9 (31.1)	3 (20.0)	
Tumor staging, N (%)			0.19
I	6 (25.0)	0 (0.0)	
II	11 (45.8)	7 (63.6)	
III	7 (29.2)	4 (36.4)	
Type of other complication, N (%)			0.30
Bowel obstruction	1 (3.4)	-	
Wound infection	1 (3.4)	-	
No significant difference was found.			

Figures

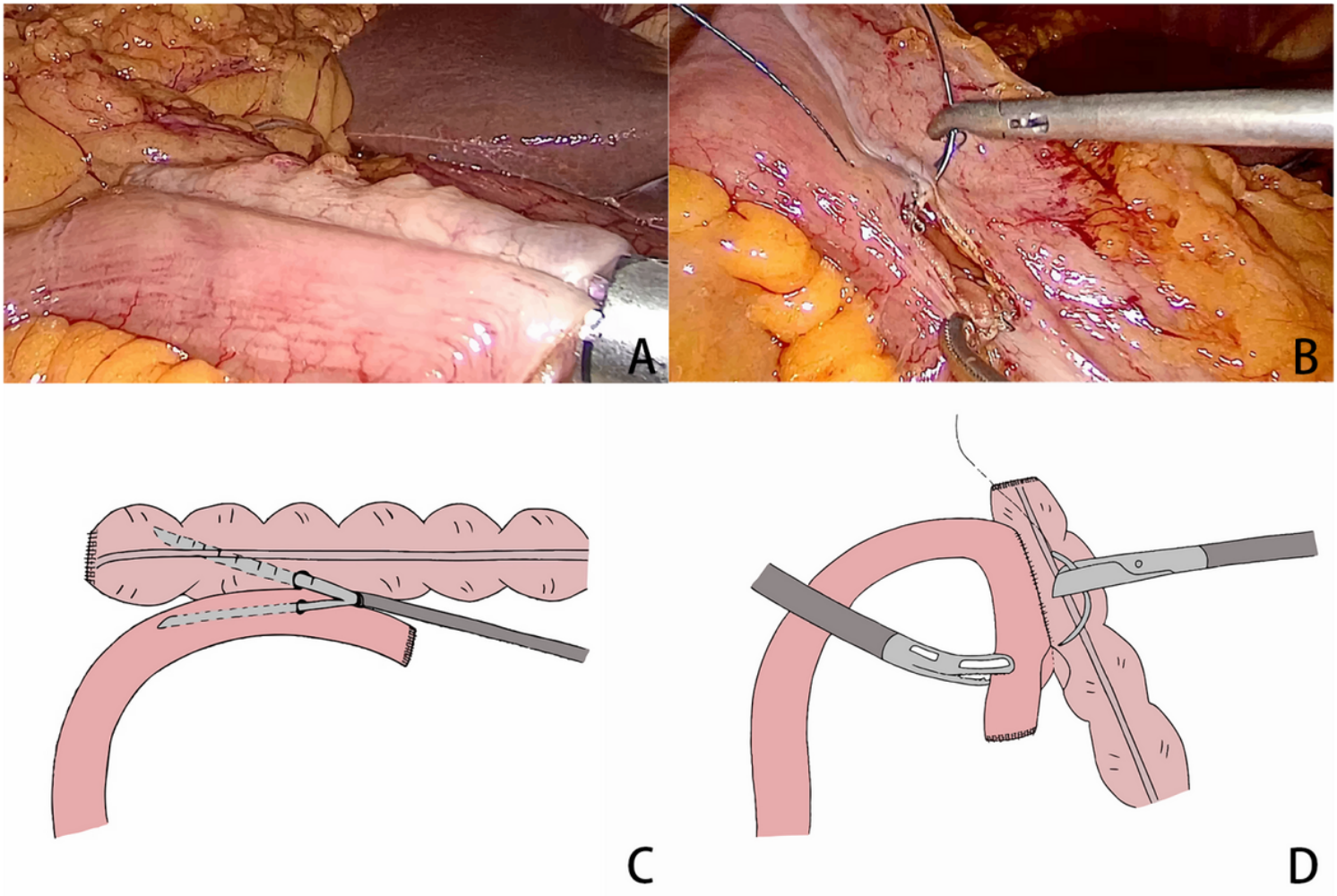

Figure 1

Key steps for IIA: (A) overlap anastomosis using a linear stapler; (B) enterotomy closure using a barbed suture; (C) schematic diagram of overlap anastomosis; (D) schematic diagram of enterotomy closure in TLRC.

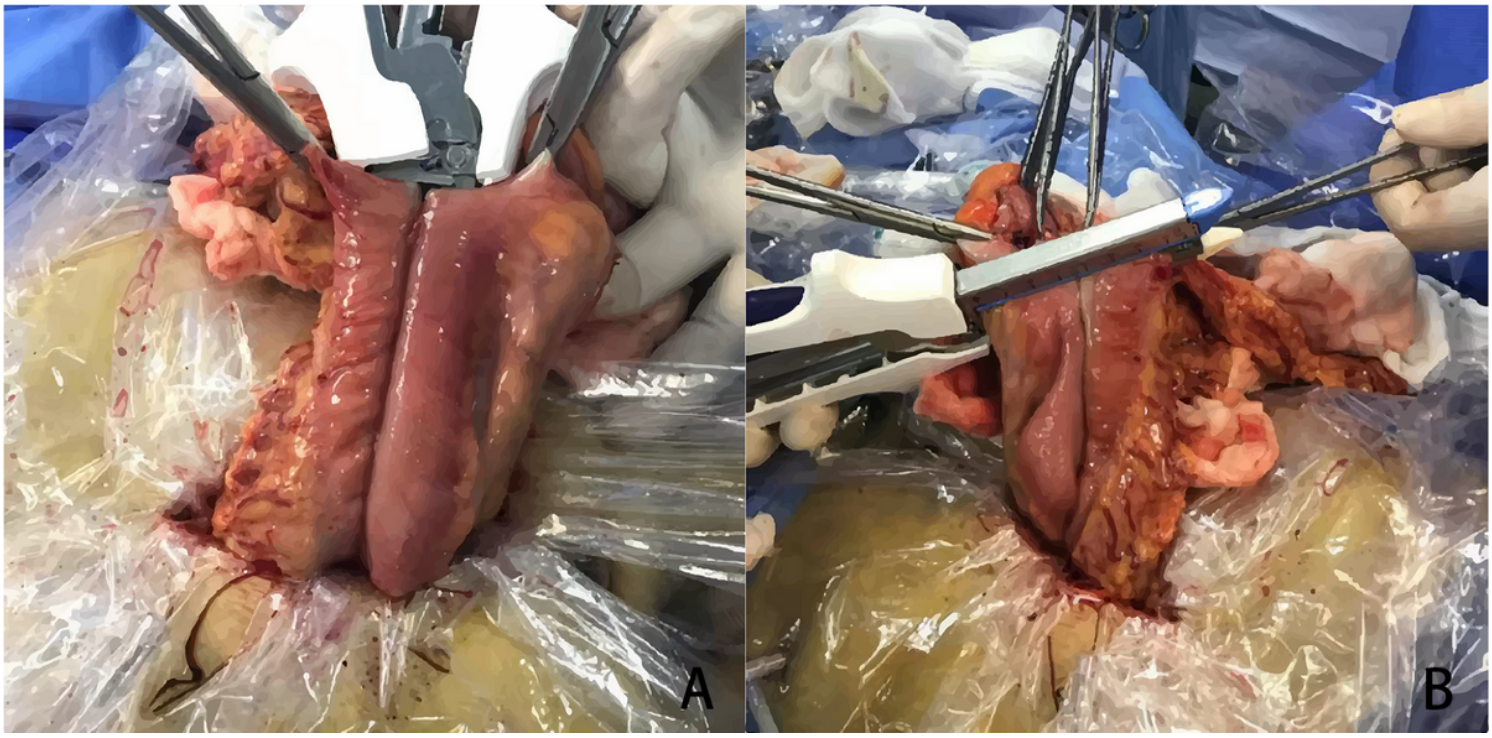

Figure 2

Key steps for EIA: (A) side-to-side anastomosis using a linear cutter; (B) enterotomy closure using a linear cutter.

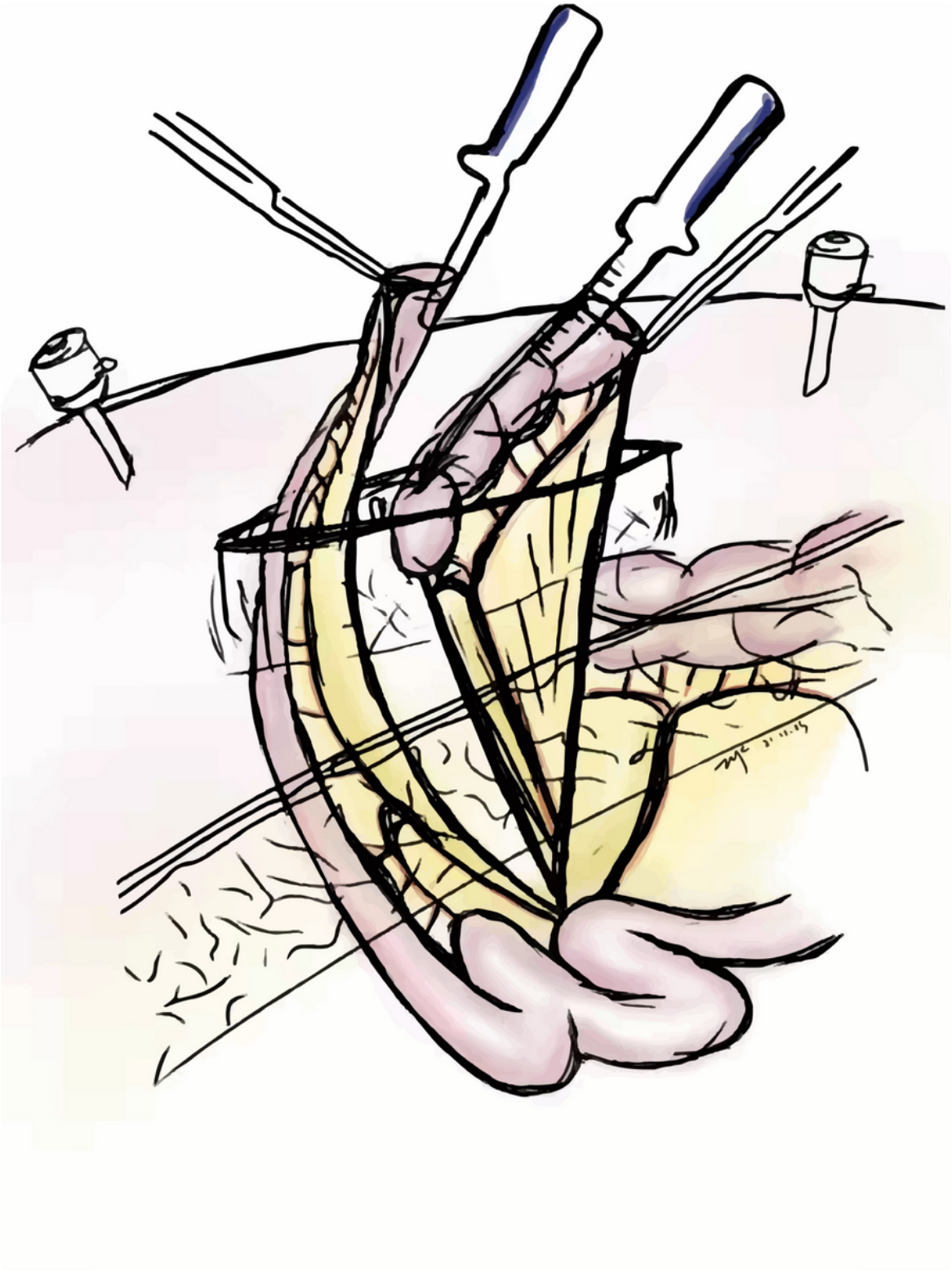

Figure 3

Schematic diagram of the bowel being pulled out of the body in EIA.