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Extracorporeal versus intracorporeal anastomosis for right colon cancer surgery

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Laparoscopic right colectomy is currently considered the standard treatment for right colon cancer. After excision of the right colon, minimally invasive options for ileocolonic anastomosis include extracorporeal anastomosis (EA) and intracorporeal anastomosis (IA). However, the choice of anastomotic technique remains debated. As the entire IA is performed in the abdominal cavity, it is known for its advantages of a faster intestinal recovery and small incision. However, IA is time-consuming and technically difficult, limiting its widespread use. Recently, the robotic approach has increased the adoption of intracorporeal anastomotic techniques owing to the benefits of endowrist-articulated instruments and staplers. Except for a small incision and faster bowel recovery, the outcomes of the two anastomoses methods are inconsistent. To date, there has been no clear conclusion regarding whether IA or EA should be used to treat right colon cancer. This review aimed to investigate the current evidence relating to intraoperative outcomes and short-term postoperative results between both anastomotic approaches.

Keywords: Colonic neoplasms, Anastomosis, Surgical, Colectomy, Robotic surgical procedures

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INTRODUCTION

Minimally invasive surgery (MIS) is becoming the standard care for colorectal surgery [1,2]. MIS in colorectal cancer surgery has led to improved postoperative pain, a shorter hospital stay, and lower complication rates with the same oncological results than open surgery [3,4].

Laparoscopic right colectomy is now considered the standard treatment for right colon cancer [5]. After excision of the right colon, minimally invasive options for ileocolonic anastomosis include extracorporeal anastomosis (EA) and intracorporeal anastomosis (IA). However, the choice of anastomotic technique remains debated.

EA consists of externalization of the diseased segment through a mini-laparotomy and subsequent anastomosis using standard open methods. The specimen extraction site is typically at the midline, and the EA is technically simpler. However, the incidence of incisional hernia in the midline is as high as 8% to 12% [6,7]. In obese patients, mobilization of the transverse colon to reach the midline extraction site may be a technical challenge, which can lead to increased bowel manipulation, excessive traction, mesenteric tears, and bleeding. Further, this can result in lengthening of the incision. This may contribute to a longer gastrointestinal recovery and postoperative ileus [7].

In contrast to EA, IA allows for less bowel manipulation and restoration of the bowel within the abdomen. IA reduces the risk of tension during anastomotic formation and allows easy specimen extraction through smaller incisions. The extraction site

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can be anywhere on the abdominal wall or through a natural orifice, potentially reducing the risk of midline incisional hernia [8]. However, IA is more technically challenging, as it requires advanced laparoscopic skills and is time-consuming [9,10]. Therefore, the decision between IA and EA is ultimately dictated by the surgeon's preference and expertise [10].

In Korea, many surgeons performing minimally invasive right colectomy still use an extracorporeal approach. During the 2022 annual meeting of the Korean Society of Coloproctology, we conducted a survey on anastomotic techniques after resection of the right colon. It was found that 54% of the surgeons performed EA and only 46% performed IA. Regarding the reasons for not performing IA, 25% reported no advantages over EA, and 45% answered that IA is a time-consuming procedure. Moreover, 36% reported that IA was time-consuming and had no added advantages.

Recently, the robotic approach has increased the adoption of IA owing to the benefits of endowrist-articulated instruments that permit precise dissection, suturing, and stapling with seven degrees of freedom. Robotic IA can be easily performed without additional stress to the surgeon and without any complications [11].

To date, there has been no clear conclusion regarding whether IA or EA should be used to treat right colon cancer. This review aimed to investigate the current evidence relating to intraoperative outcomes and short-term postoperative results between both anastomotic approaches.

EXTRACORPOREAL ANASTOMOSIS

Right colectomy usually starts with central vascular ligation followed by mobilization of the bowel and lateral dissection of the terminal ileum and colon attachments. Complete mesocolon excision is performed according to oncological principles.

Additional mobilization of the transverse colon may be required for EA. After more comprehensive colon mobilization, the terminal ileum and right or proximal transverse colon are exteriorized through a midline or transverse skin incision with a wound protector in place. Mesocolic vessel ligation and mesocolon division are performed using extracorporeal ligation and energy devices.

The appropriate site for bowel transection is determined through oncological principles, visual inspection of bowel color, and bleeding of the marginal artery. The ileocolic anastomosis is created similarly to the standard open methods using the side-to-side, end-to-side stapler, or isoperistaltic end-to-end hand-sewn method.

INTRACORPOREAL ANASTOMOSIS

After central vascular ligation and complete mesocolic excision, further transverse colon mobilization is not required for IA. Mesocolon division is performed intracorporeally using energy devices. The appropriate site of bowel transection is determined through oncological principles, visual inspection of bowel color, and the indocyanine green perfusion test. The transverse colon and terminal ileum are transected using a laparoscopic or robotic stapler, and the resected specimen is placed in the abdomen until the end of the anastomosis.

The terminal ileum and colon are aligned in a side-to-side (iso- or antiperistaltic) fashion with a stay suture. Whether a stay suture is implemented depends on the operator's preference. A laparoscopic or robotic linear stapler is applied through two small enterotomies, and the common channel is closed with a stapler or hand-sewn fashion. The specimen is removed with a wound protector in place anywhere on the abdominal wall, usually through a Pfannenstiel incision or through a natural orifice, such as transvaginal or transrectal specimen extraction.

OPERATIVE OUTCOMES

A prospective, multicenter, comparative study comparing IA and EA for robot-assisted and laparoscopic right colectomy found that IA was associated with significant improvements in conversion rates (0% vs. 5%, $p = 0.007$), a shorter extraction site incision length (4.9 cm vs. 6.2 cm, $p \leq 0.0001$), and longer operative time (156.9 minutes vs. 118.2 minutes, $p < 0.0001$) than EA [12]. Table 1 shows the operative outcomes such as conversion rate, incision length, operation time, harvested lymph node, and blood loss in recent studies. A randomized controlled trial (RCT) comparing laparoscopic IA and EA found that the operative time was significantly longer (median, 149 minutes vs. 123 minutes; range, 95–215 minutes vs. 60–240 minutes; $p < 0.001$) in the IA group, and the wound length (6.7 cm vs. 8.7 cm; range, 4–9.5 cm vs. 5–13 cm; $p < 0.001$) was significantly less in the IA group than in the EA group [13]. However, in a meta-analysis, the operation time was not significantly different between IA and EA [14,15]. Intracorporeal suturing in IA is the most challenging and time-consuming procedure for surgeons, whereas the widespread use of barbed sutures facilitates the procedure and results in a similar operation time between IA and EA [15,16]. Laparoscopic IA is not widely used because of difficulties in suturing and stapling, but it is being implemented with robots owning to the advantages of endowrist-articulated instruments. IA is performed more often with the robotic approach, whereas EA is performed more often with the laparoscopic approach [12]. Sorgato et al. [17] reported that operative time was not statistically different between robotic IA and laparoscopic IA (robotic group, 265.9 minutes vs. laparo-

Table 1. Operative outcomes

Study	Year	Conversion rate (%)		Incision length (cm)		Operative time (min)		Harvested lymph node		Blood loss	
		IA	EA	IA	EA	IA	EA	IA	EA	IA	EA
Cleary et al. [12]	2022	0	5	4.9 ± 1.4	6.2 ± 3.6	156.9 ± 50.2	118.2 ± 43.5	23.3 ± 10.0	24.2 ± 9.5	1.3%[a)]	0.8%[a)]
Bollo et al. [13]	2020	0	0	6.7 (4–9.5)	8.7 (5–13)	149 (95–215)	123 (60–240)	19.7 ± 6.0	19.1 ± 7.1	8.8 ± 1.7[b)]	17.1 ± 1.7[b)]
Ferrer-Márquez et al. [16]	2021	1.2	2.98	6.38 ± 1.34	8.62 ± 3.13	100.1 ± 37.4	97.3 ± 28.0	NR	NR	NR	NR
Frigault et al. [19]	2022	NR	NR	NR	NR	160 ± 31	138 ± 42	32 ± 11	30 ± 13	41 ± 43 (mL)	53 ± 69 (mL)

Values are presented as mean ± standard deviation or median (range) unless otherwise specified.
IA, intracorporeal anastomosis; EA, extracorporeal anastomosis; NR, not reported.
[a)]Intraoperative blood transfusion. [b)]Decrease in hemoglobin level (g/L).

scopic group, 254.2 minutes; $p = 0.29$). Robotic surgery allowed for a shorter suture time during IA in right colectomy.

The incision length was significantly shorter in the IA group than that in the EA group [12,15,18]. The extraction incision size is limited only by the size of the diseased segment in IA, but extension of the incision is necessary to enable the transverse colon to reach and complete the EA. Undoubtedly, a shorter incision is an important factor associated with reduced postoperative pain [15].

In the meta-analysis, the specimen extraction sites were Pfannenstiel incision (63.7%), midline (21.5%), transverse (8.0%), and others (6.8%) in the IA group, while 43.1% were midline incisions and 48.0% were transverse incisions in the EA group [15]. A potential advantage of the Pfannenstiel incision is its cosmetic effect owning to its invisibility.

In terms of harvested lymph nodes, dissection of at least 12 lymph nodes is the basis to ensure a radical cure. A meta-analysis of five RCTs showed no significant difference in the number of harvested lymph nodes (mean difference [MD], 0.40; 95% confidence interval [CI], –1.63–2.43, $p = 0.70$) between the two groups [15].

Regarding intraoperative blood loss, in a systematic review, volume of intraoperative blood loss was lower in IA group compared with EA group (MD, –7.76; 95% CI, –13.48 to –2.04; $p < 0.01$) [18]. The authors hypothesized that this phenomenon may be related to clear visualization of mesentery during the procedure, refinements of laparoscopic techniques and wide application of efficient laparoscopic instruments for effective hemostasis. However, several studies have reported no difference between the two groups regarding intraoperative blood loss [12,19].

POSTOPERATIVE OUTCOMES

EA requires greater mobilization and exteriorization of the bowel through a longer incision. It may cause tissue injury to the mesentery and affect bowel function [20]. The potential advantages of IA include a faster return of gastrointestinal recovery, fewer complications, and shorter length of hospital stay. Table 2 shows the postoperative outcomes such as bowel recovery, ileus, anastomotic leak rate, surgical site infection (SSI), reoperation rate, and duration of hospital stay in recent studies.

A meta-analysis of four RCTs showed that IA was associated with a quicker return to normal physiological function with equivalent postoperative morbidity [14]. Patients with IA had a significantly lower incidence of postoperative ileus (relative risk [RR], 0.53; 95% CI, 0.3–0.94; $p = 0.03$).

In a meta-analysis involving 559 patients from five RCTs, there were significantly better outcomes in the IA group than in the EA group in terms of time to the first flatus (MD, –0.71; 95% CI, –1.12 to –0.31; $p = 0.0005$), time to first passage of stool (MD,

Table 2. Postoperative outcomes

Study	Year	Bowel recovery (day)		Ileus (%)		Anastomotic leak (%)		SSI (%)		Reoperation (%)		Readmission (%)		Incisional hernia (%)		Hospital stay (day)	
		IA	EA	IA	EA	IA	EA	IA	EA	IA	EA	IA	EA	IA	EA	IA	EA
Cleary et al. [12]	2022	1.5 ± 1.0[a]	1.8 ± 1.0[a]	4.5	1.6	0.6	0	1.3	0	0.6	0	2.6	0.8	NR	NR	4.2 ± 3.1	4.4 ± 1.5
Bollo et al. [13]	2020	2.3 (1–7)[b]	3.3 (1–15)[b]	13	30	4	7	4	4	1	5	0	7	NR	NR	5.7 (2–19)	6.6 (2–23)
Ferrer-Márquez et al. [16]	2021	NR	NR	22.0	19.2	4.9	7.7	3.7	16.7	7.3	12.8	6.09	3.85	NR	NR	11.1 ± 20.7	8.5 ± 5.75
Frigault et al. [19]	2022	2 (2–3)[a]	2 (1–3)[a]	17.2	9.0	0	2.3	4.7	2.3	0	0.9	7.8	5.9	1.6	11.3	4 (3–6)	4 (3–6)
Ishizaki et al. [27]	2021	2 (1–4)[a]	2 (1–4)[a]	5.9	8.0	0	0	7.8[c]	0[c]	NR	NR	NR	NR	NR	NR	10 (7–16)	11 (7–23)

Values are presented as mean ± standard deviation or median (range) unless otherwise specified.

SSI, surgical site infection; IA, intracorporeal anastomosis; EA, extracorporeal anastomosis; NR, not reported

[a]Time to first flatus (day). [b]Time to first passage of stool (day). [c]Organ/space SSI.

–0.53; 95% CI, –0.69 to –0.37; $p < 0.00001$), and wound infection (RR, 0.46; 95% CI, 0.23–0.91; $p = 0.02$). However, there were no statistically significant differences between the two groups with regard to postoperative ileus (RR, 0.72; 95% CI, 0.3–1.77; $p = 0.48$) [15].

Zheng et al. [18] in a systematic review reported that IA is associated with a significantly earlier bowel recovery ($p < 0.01$), and shorter hospitalization duration ($p < 0.01$) than EA. The postoperative ileus was similar between the IA and EA groups ($p > 0.05$).

MIS has been recognized for a faster postoperative bowel recovery than open surgery, studies have consistently demonstrated that IA is associated with a faster recovery of bowel function than EA. The mechanism for faster recovery of bowel function in IA is unknown, but less bowel manipulation, leading to less traction and fewer tissue injuries to the mesentery, is believed to be involved.

In terms of gastrointestinal recovery, previous studies have not shown consistent results. An RCT of 140 patients comparing laparoscopic IA and EA found that the gastrointestinal function recovered earlier in patients with an IA (median, 2.3 days vs. 3.3 days; $p = 0.003$) and the incidence of ileus was lower (13% vs. 30%, $p = 0.022$) [13]. In contrast, Frigault et al. [19] reported that the median time to the first flatus was longer in the IA group ($p = 0.049$), with a trend toward more ileus (17.2% vs. 9.0%, $p = 0.07$). This is probably because the definition of ileus is different in each study, and ileus is associated with a number of factors, and one of the most important factors is prior abdominal surgery.

Anastomotic leaks are one of the most feared complications of colorectal surgery, and a recent multicenter randomized clinical trial reported an incidence of 6.25% of anastomotic leaks in laparoscopic right colectomies [16]. This study showed that the leakage rate (4.9% vs. 7.7%, $p = 0.527$) was not significantly different between IA and EA.

IA is expected to have worse outcomes in anastomotic leak compared to EA as IA is technically difficult; however, a recent systematic review reported that the EA group showed a worse anastomotic leak rate [21]. Potential reasons may be compromised vascular supply following mesenteric injuries caused by exteriorization of the bowel, traction, and hand-sewn anastomosis [14,22,23]. Two recent meta-analyses reported no significant differences in the rate of anastomotic leaks between the IA and EA (RR, 1.34; 95% CI, 0.58–3.13; $p = 0.5$ and odds ratio [OR], 0.81; 95% CI, 0.56–1.16; $p = 0.25$) [14,18]. This is probably because staplers were also used mostly in the EA group. The latest evolution in MIS is robotics, with improved dexterity and robotic staplers. The robotic platform allows for a shorter suture time during IA in the right colectomy. Recent studies have reported uniformly low rates of anastomotic leakage. The overall reported rates of anastomotic leak following robotic right colectomy are low, ranging between 0.9% and 3.8% [24-26].

Regarding SSI, theoretically, the intraperitoneal incision into the bowel lumen in IA may cause fecal spillage, which can lead to SSI. Although mechanical bowel preparation is performed, fecal spillage can often occur due to residual feces or poor bowel preparation. Ishizaki et al. [27] reported that the frequency of organ/space SSI in the IA group was significantly higher than that in the EA group (7.8% vs. 0%, $p = 0.04$). The risk of SSI score, which was defined as the dose of bacterial contamination, was significantly higher in the IA group than in the EA group (median, 9 vs. 1, $p < 0.01$). However, in recent meta-analyses, there is no difference in SSI (RR, 0.53; 95% CI, 0.17–1.64; $p = 0.27$), or rather, better results in the IA group (RR, 0.46; 95% CI, 0.23–0.91; $p = 0.02$) [14,15]. Studies have shown that the longer incision and exposure time of the incision are considered risk factors for wound infection [18].

Another outcome of interest used to compare IA and EA is reoperation and readmission within 30 days. A recent meta-analysis reported no significant differences in the rate of reoperation (RR, 0.72; 95% CI, 0.37–1.41; $p = 0.34$) and readmission (RR, 0.60; 95% CI, 0.25–1.45; $p = 0.26$) between the two groups [15].

With regard to incisional hernia, not only incision length but also the location of incision may affect the development of incisional hernia. The extraction site incision in the EA is usually at the midline, whereas extraction of the specimen in IA can be anywhere on the abdominal wall, potentially reducing the risk of midline incisional hernia [8]. A meta-analysis showed that patients with EA had a significantly higher odds of incisional hernia (OR, 3.14; 95% CI, 1.85–5.33; $p < 0.001$) [21].

Regarding hospital stay, a faster return of gastrointestinal recovery should lead to a shorter hospital stay, but it does not show consistent results. A prospective, multicenter, comparative study comparing IA and EA found that IA was associated with significantly shorter hospital stay (median, 3 days vs. 4 days; $p \leq 0.0001$) [12]. However, in a meta-analysis, the hospital stay was not significantly different between IA and EA (MD, −0.07; 95% CI, −0.27–0.13; $p = 0.47$) [15]. This is expected because the discharge protocol differs between the previous studies.

CONCLUSIONS

IA and EA are options for MIS to maintain intestinal continuity after right colon cancer resection. IA is associated with significant improvements in short-term outcomes, including incision size, variety of wound incision sites for specimen retraction, and a quicker return of bowel function, with equivalent morbidity. However, intracorporeal techniques are more technically challenging, as they require advanced laparoscopic skills. The robotic approach has increased the adoption of intracorporeal anastomotic techniques owing to the benefits of endowrist-articulated instruments and staplers. Robotics facilitates intracorporeal suturing during right colectomy, and significantly reduces the duration of IA.

Nevertheless, additional large-scale randomized controlled studies are needed to confirm the benefits of IA in laparoscopic and robotic right colectomy.

NOTES

Conflict of interest

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