Does Intracorporeal Anastomosis Decrease the Rate of Surgical Site Infection in Laparoscopic Colon Cancer Surgery?

Yeon Wook Ju¹, Woong Bae Ji², Jung Sik Kim², Kwang Dae Hong², Jun Won Um²

¹Division of Colon and Rectal Surgery, Korea University Guro Hospital, Seoul, South Korea
²Division of Colon and Rectal Surgery, Korea University Ansan Hospital, Ansan, South Korea

Objective: This study aimed to compare the surgical site infection (SSI) rates between intracorporeal anastomosis (ICA) and extracorporeal anastomosis (ECA).

Summary of background data: Laparoscopic surgery is recommended for colonic malignancies because of its superior clinical outcomes and comparable oncologic results. Laparoscopic colectomy with ICA has the advantages of incision length and free extraction site choice. However, ICA may be associated with a risk of SSI due to enterotomy inside the abdominal cavity.

Methods: We retrospectively analyzed patients with colon cancer who underwent radical surgery at Korea University Ansan Hospital between January 2017 and June 2020. We compared the SSI rates and other clinical variables between the ICA and ECA groups.

Results: Of the 502 patients who underwent radical surgery for colorectal cancer during the study period, 234 were eligible for inclusion. ECA and ICA were performed in 62.4% and 37.6% of patients, respectively. There were no statistically significant intergroup differences in clinicopathologic variables. The overall SSI rate did not differ between the groups (P = 0.801), but organ/space SSIs were more common in the ICA group than in the ECA group (P = 0.048).

Conclusions: There was no significant difference in overall SSI or anastomotic leakage (AL) rates between the ICA and ECA groups, but the organ/space SSI rate was higher in the ICA group when AL cases were excluded. Further high-quality studies are needed to assess the risk of organ/space SSIs in the ICA after colon cancer surgery.

Key words: Colon cancer – Anastomosis – Intracorporeal anastomosis – Surgical site infection – Infection
Colorectal cancer is one of the most common cancers worldwide. In the United States, colorectal cancer is ranked as the third most common cancer in men and women and was the third most deadly cancer in 2019. In South Korea, colorectal cancer is ranked as the third most newly diagnosed cancer, with 55 patients diagnosed per 100,000 people in 2016.

Laparoscopic colorectal surgery requires an adequate-sized extraction site for specimen extraction, and extracorporeal anastomosis (ECA) using an extraction site is widely used by many surgeons. Studies on totally laparoscopic colon surgery via intracorporeal anastomosis (ICA) have been ongoing since the early days of laparoscopic colorectal surgery, and many studies have discussed its various advantages. ICA requires a longer operation time, but it can be gradually reduced with experience. In ICA, the extraction site can be freely selected, thereby reducing the risk of incisional hernia and decreasing the length of stay. Furthermore, wound length can be reduced, especially in obese patients.

However, there have been concerns that anastomosis, enterotomy, and fecal spillage (depending on the degree of bowel preparation) in ICA might increase the risk of surgical site infection (SSI). Nevertheless, studies have reported that ICA has a similar SSI rate or even a decreased rate in several meta-analyses. However, it is rarely classified according to a standardized definition of SSI, and many studies have targeted only superficial or deep SSIs. Furthermore, limited studies have assessed intraabdominal abscess or organ/space SSI caused by fecal spillage. Therefore, data on wound site infection, fecal spillage, and organ/space SSI that may occur due to enterotomy are needed.

Material and Methods

Patient selection

Patients who underwent laparoscopic colectomy between January 2017 and December 2019 at Korea University Ansan Hospital were included. Patients treated with ECA and those treated with ICA were also compared. Patients with sigmoid colon cancer and rectal cancer were excluded because anastomosis was performed using a circular stapler through the anus and rectum. In addition, patients who received antibiotics within a week before surgery, those who received chemotherapy or immunosuppressive drugs within a month before surgery, or those who underwent emergency surgery and conversion were excluded. Conversion was defined as the case in which any procedure, except specimen extraction, was performed using an incision other than the planned incision.

Operation

In total, 4 to 5 trocars were positioned according to the cancer location. For right-sided cancer, 10-mm transumbilical, 12-mm left upper quadrant (LUQ), 5-mm left lower quadrant (LLQ), 5-mm right lower quadrant (RLQ), and 5-mm right upper quadrant (RUQ; optional) trocars were used. For left-sided cancer, 10-mm transumbilical, 12-mm RLQ, 5-mm RUQ, 5-mm LLQ, and 5-mm LUQ (optional) trocars were used. For ECA, specimen extraction was performed by extending the transumbilical trocar site. ICA was performed by extending the transumbilical incision or using a Pfannenstiel incision. Radical surgery was performed, except in cases of palliative resection. All radical surgeries involved D3 lymph node dissection, whereas early right-sided colon cancer involved D2 lymph node dissection in some cases.

ECA was performed through extension of the umbilical trocar site or midline wound of the LLQ, and functional end-to-end anastomosis was performed using a linear or circular stapler. ICA was performed by proximal and distal resection of the specimen using linear staplers, followed by enterotomy in the colon and anastomosis in an antiperistaltic or isoperistaltic manner using a linear stapler. In all cases, the enterotomy was closed twice with barbed sutures. In ICA cases, a drain tube was inserted in all patients, whereas in ECA cases, a drain tube was inserted if it was judged necessary by the operator.

Mechanical bowel preparation (MBP) was performed using a polyethylene glycol (PEG)-based solution, but in some cases, only enema was performed. Oral antibiotic bowel preparation was not performed in any case.

SSI assessment

SSI was defined according to the definition of the Centers for Disease Control and Prevention/National Healthcare Safety Network. Superficial SSI was defined as involvement of only the skin and subcutaneous tissue of the incision. Cases of erythema, swelling, tenderness, or wound opening due to discharge were considered as SSI cases.
However, cases in which culture results were negative were not considered SSI cases. Deep SSI was identified when the depth of infection extended below the fascial layer. Organ/space SSI was defined as involvement of any part of the anatomy other than the incision, which was opened or manipulated during operation. Anastomotic leakage was included in organ/space SSIs noted within 30 days. Postoperative complications were prospectively recorded. Cases of erythema, swelling, tenderness, or wound opening due to discharge were considered as SSI cases. However, cases in which culture results were negative were not considered SSI cases.

Anastomotic leakage was confirmed by percutaneous drainage or emergency surgery when the color of the drainage changed, clinical peritonitis was present, or free air was seen along with complicated fluid collection that was suggestive of anastomotic leakage.

Data analysis

Continuous data were analyzed using Student’s t test, while categoric data were analyzed using a logistic regression test or the chi-square test with Fisher’s exact test. Multivariate analysis was performed using logistic regression analysis of the factors that could affect SSI. All analyses were two-sided, and statistical significance was set at P < 0.05. All statistical analyses were performed using SPSS version 25 (IBM, Armonk, NY).

Results

Of the 502 patients who underwent surgery for colorectal cancer between January 2017 and June 2020, 234 patients were included in the study. ECA and ICA were performed in 146 and 88 patients, respectively. There were no intergroup differences in clinicopathologic variables, except for the type of bowel preparation; MBP (81.82%) using PEG was used more commonly in the ICA group, while enema only was used more commonly in the ECA group (57.53%) (P < 0.001). The mean operative time was shorter in the ECA group than in the ICA group (162.70 minutes versus 171.96 minutes), but the difference was not statistically significant (P = 0.107; Table 1). Ileocolic anastomosis was performed in 63.0% and 61.4% of the ECA and ICA groups, respectively (P = 0.893).

There were no intergroup differences in postoperative results. The mean length of postoperative hospital stay was slightly longer in the ICA group than in the ECA group, but the difference was not significant (P = 0.940). Furthermore, there was no difference between the groups in refeeding and defecation times. The overall SSI rate was 8.90% in the ECA group and 7.95% in the ICA group, but the difference was not statistically significant (P = 0.801). The anastomotic leakage rate was 2.05% in the ECA group and 2.27% in the ICA group; however, the difference was not statistically significant (P = 0.911). However, when cases of SSI were categorized based on superficial/deep SSI and organ/space SSI, the rate of the latter was significantly higher in the ICA group than in the ECA group when anastomotic leakage cases were excluded (Table 2).

Multivariate analysis of the overall SSI cases confirmed that the SSI rate increased with increasing

Table 1  Clinicopathologic characteristics of ECA and ICA groups

|                  | ECA (n = 146) | ICA (n = 88) | P value |
|------------------|---------------|--------------|---------|
| Male sex, n (%)  | 69 (47.3)     | 41 (46.6)    | 0.921   |
| Age              | 68.02         | 66.92        | 0.914   |
| BMI              | 23.86         | 23.34        | 0.161   |
| Cancer location  |               |              | 0.699   |
| Ascending        | 68            | 42           |         |
| Hepatic flexure  | 19            | 12           |         |
| Transverse       | 25            | 7            |         |
| Splenic flexure  | 8             | 5            |         |
| Descending       | 26            | 22           |         |
| ASA, n (%)       |               |              | 0.142   |
| <3               | 124 (84.9)    | 65 (73.9)    |         |
| ≥3               | 22 (15.1)     | 23 (26.1)    |         |
| Smoking status, n|               |              | 0.051   |
| Current smoker   | 22            | 26           |         |
| Current non-smoker| 124          | 62           |         |
| Mechanical bowel, n preparation |        |              | <0.001  |
| No               | 26            | 7            |         |
| PEG              | 36            | 72           |         |
| Enema only       | 84            | 9            |         |
| Preoperative CEA, ng/mL | 13.18       | 4.79         | 0.321   |
| Pathologic stage |               |              | 0.609   |
| 0, I             | 39            | 14           |         |
| II               | 45            | 37           |         |
| III              | 44            | 28           |         |
| IV               | 18            | 9            |         |
| Operative time, min (minutes) | 162.70   | 171.96       | 0.107   |
| Anastomosis type, n (%) | 0.893        |              |         |
| Ileocolic        | 92 (63.0)     | 54 (61.4)    |         |
| Colocolic        | 54 (37.0)     | 34 (38.6)    |         |
| Drainage catheter, n (%) | 115 (78.8) | 88 (100)     | <0.001  |
| Tumor size, cm   | 4.43          | 5.45         | 0.863   |

ASA, American Society of Anesthesiologists; BMI, body mass index; CEA, carcinoembryonic antigen; ECA, extracorporeal anastomosis; ICA, intracorporeal anastomosis; PEG, polyethylene glycol.
operation time, but the ICA group did not have an increased SSI rate compared to the ECA group [odds ratio (OR), 0.958; 95% confidence interval (CI), 0.136–6.754]. Current smokers tended to have a higher SSI rate than non-current smokers (OR: 4.462), with a statistically significant difference (95% CI: 1.184–16.805). In addition, the SSI rate was not significantly lower in cases of MBP based on PEG than in cases of no enema or MBP (OR: 1.632; 95% CI: 0.343–7.756) (Table 3).

Discussion

The use of a totally laparoscopic approach, including ICA, can eliminate problems such as mesenteric laceration that can occur when a specimen is pulled out through a thick abdominal wall, especially in obese patients. Current smokers tended to have a higher SSI rate than non-current smokers (OR: 4.462), with a statistically significant difference (95% CI: 1.184–16.805). In addition, the SSI rate was not significantly lower in cases of MBP based on PEG than in cases of no enema or MBP (OR: 1.632; 95% CI: 0.343–7.756) (Table 3). Many studies on the relationship between ICA and SSI have reported results in wound site infections and did not classify superficial, deep, or organ/space SSI. The results for SSI in most meta-analyses were also analyzed by summarizing studies showing results without clear SSI classification but collectively as overall SSI. However, organ/space SSIs, such as intraabdominal abscesses, may occur in some cases, as shown in our study. If the bowel preparation is insufficient or the stool is liquid, fecal material may spill into the enterotomy site after stapling, causing organ/space SSI.

MBP was often not performed in many studies of SSI after ICA. It is obvious that MBP is not related to anastomotic leakage or SSI, and it seems that MBP was not performed to ensure rapid recovery of bowel function, as in enhanced recovery after surgery protocol. However, the current bowel preparation guidelines for reducing SSI recommend simultaneous MBP and oral antibiotic bowel preparation. In this case, if MBP is insufficient, ICA may increase the risk of SSI. Although it is an early laparoscopic surgery, ICA requires meticulous bowel preparation, according to Franklin et al. A previous study has reported that MBP is more likely to be associated with generalized peritonitis because the fecal material is more liquid, thereby increasing the need to perform emergency surgery when leakage occurs. Therefore, more studies are needed to support the changes in the current bowel preparation guidelines.

Many factors can affect the SSI rate during colon surgery. All patients in the ICA group underwent a midline incision for the extraction site. In contrast, the extraction site of the patients in the ECA group was heterogeneous. Benlice et al reported that right lower or left lower quadrant wounds can have lower

| Table 2 | Univariate analysis of ECA and ICA groups |
|---------|------------------------------------------|
|          | ECA (n = 146) | ICA (n = 88) | P value |
| Postoperative hospital stay, days | 7.75 | 8.81 | 0.940 |
| Time to resume diet, days | 2.75 | 2.80 | 0.196 |
| Flatus passage, days | 2.60 | 3.36 | 0.859 |
| Stool passage, days | 3.16 | 4.93 | 0.856 |
| Overall SSI, n | 13 | 7 | 0.801 |
| Superficial or deep SSI, n | 11 | 2 | 0.089 |
| Organ/space SSI, n | 4 | 6 | 0.135 |
| Anastomotic leakage (AL), n | 3 | 2 | 0.911 |
| Organ/space SSI excluding AL, n | 1 | 4 | 0.048 |
| Ileus, n | 6 | 7 | 0.214 |
| Chylous ascites, n | 13 | 5 | 0.370 |
| Postoperative bleeding, n | 0 | 0 | – |
| Postoperative 30-day mortality, n | 0 | 0 | – |

| Table 3 | Multivariate analysis of risk of SSI |
|---------|-------------------------------------|
|          | OR | Lower | Upper | P value |
| BMI | 1.134 | 0.984 | 1.307 | 0.083 |
| ASA > 2 | 0.942 | 0.261 | 3.398 | 0.928 |
| Current smoker | 4.462 | 1.184 | 16.805 | 0.027 |
| MBP (PEG vs. no MBP or enema only) | 1.632 | 0.343 | 7.756 | 0.538 |
| Operation time | 1.010 | 1.001 | 1.019 | 0.031 |
| ICA | 0.958 | 0.136 | 6.754 | 0.965 |

ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval; ICA, intracorporeal anastomosis; MBP, mechanical bowel preparation; OR, odds ratio; PEG, polyethylene glycol; SSI, surgical site infection.
SSI rate compared to midline or Pfannenstiel incision. However, the number of patients was very small, and most SSI guidelines do not recommend a specific extraction site. A wound protector can reduce the SSI rate significantly. Allegrenzi et al. reported in their meta-analysis that a single- or double-ring wound protector can significantly reduce the SSI rate (HR: 0.25, 95% CI: 0.13–0.50). We inserted a wound protector after the incision for specimen extraction in all cases. There is insufficient evidence regarding whether drains should be inserted after ICA. Since studies have shown that drainage tube insertion does not provide any benefit after colon surgery, many institutions do not perform drainage tube insertion after laparoscopic colectomy. However, in ICA cases, enterotomy is performed in the abdominal cavity and fecal spillage can occur; hence, a drain tube was inserted in all patients included in our study. However, further studies are required to clarify this.

The definition of anastomotic leakage varies among studies. Rahbari et al. analyzed the definitions of anastomotic leakage after anterior resection in previous studies and recommended a consensus definition of anastomotic leakage. They stated that anastomotic leakage should be defined as communication between the intra- and extraluminal compartments owing to a defect in the integrity of the intestinal wall. Moreover, they recommended considering pelvic abscess near the abscess cavity as anastomotic leakage. However, there can be organ/space SSIs other than anastomotic leakage. There were 4 cases of O/S SSI other than anastomotic leakage in the ICA group. The first case was a patient with partial obstruction who had unsatisfactory mechanical bowel preparation, which we had not noticed. After ICA with a linear stapler, fecal content spilled out. Therefore, we had to irrigate massively, but the patient experienced an intrabdominal abscess at the liver dome area far from the anastomosis area. The second and third cases were female patients with postoperative fever and turbid drain color. Therefore, we changed the JP drain to a pigtail catheter and performed a contrast study; however, there was no connection between the abscess cavity and the bowel. Therefore, we thought that it was not anastomotic leakage. We removed the pigtail catheter after a few weeks. In the fourth case, the patient had to undergo pigtail drain insertion due to fever and fluid collection near the anastomosis site. However, the abscess near the anastomosis site was surrounded by bowel loops, and so it could not be accessed percutaneously. Therefore, we decided to perform surgical drainage. However, there was no leakage from the anastomosis; the abscess cavity was drained and irrigated, and the patient recovered from infectious complications.

The disadvantage of this study is that the number of patients in the ICA group was small; hence, the statistical power was weak. There are limitations to this retrospective study. Patient selection was determined by surgeon preference; hence, the possibility of bias was high. Furthermore, results regarding incisional hernia, an important advantage of ICA, have not been reported. However, the general results are consistent with those of previous studies and show that organ/space SSIs require more specific results.

ICA is a good option considering the incidence of incisional hernia reported in previous studies because the clinical results are similar and the overall SSI rate is similar to that of ECA, as shown in this study. However, more studies on organ/space SSIs and those reflecting recent changes in bowel preparation guidelines are needed.

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