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Case Report

Totally Laparoscopic Left Colectomy With Preoperative Simulation Using 3D CT Angiography and Intraoperative Navigation Using the Indocyanine Green (ICG) Fluorescence Method

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Introduction: Laparoscopic reconstruction after left colectomy is mostly performed with functional end-to-end anastomosis through about 5–7 cm sized incision. However, this procedure poses some problems, including increased intestinal mobilization range and parietal destruction, insufficient blood flow to the intestinal tract due to arterial arch malformation, and dominant artery dissection. In this paper, we present a case of descending colon cancer for which totally laparoscopic surgery and intracorporeal anastomosis could be performed safely with preoperative simulation and intraoperative navigation.

Case presentation: A 34-year-old male was complaint fecal occult blood positive and a colonoscopy was performed. The patient was diagnosed with descending colon cancer cT2N0N0 Stage I. Preoperative CT angiography findings showed that the inferior mesenteric artery (IMA) branched into the left colic artery (LCA) and the sigmoid arteries (S1, S2) in order and showed LCA and S1 as the dominant arteries, and a totally laparoscopic descending colectomy (D2 dissection and S2 artery preserving) was scheduled. At his operation, for investigate blood flow of anastomotic region, ICG was used. After an intravenous injection of ICG, blood flow was evaluated and intestinal dissection was performed at the scheduled dissection line. Intracorporeal anastomosis was then performed using the overlap method and a linear stapler.

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Conclusion: Although the intracorporeal anastomosis procedure has a high degree of difficulty, the use of preoperative simulation and intraoperative navigation may reduce the surgeon's intraoperative stress and enable safe and accurate intestinal dissection and anastomosis in the totally laparoscopic surgery.

Laparoscopic colectomy in the left colon may cause not only splenic and mesenteric injuries but also insufficient blood flow to the anastomotic section due to marginal arterial arch malformation; thus, extensive separation and mobilization are often necessary. Since 2017, we have suggested intracavitary anastomosis for descending colectomy cases and sigmoid colectomy cases in which the double stapling technique (DST) is difficult. We experienced a descending colon cancer case where surgery and digestive tract anastomosis could be performed safely by totally laparoscopic maneuver with preoperative simulation through preoperative three-dimensional (3D) computed tomography (CT) angiography and intraoperative navigation; this allowed visualization of intestinal blood flow using the indocyanine green (ICG) fluorescence method. Here, we report the case with a literature review.

Case

Patient

A 34-year-old male.

Chief complaint

Fecal occult blood positive.

History of present illness

Patient was confirmed to be positive for fecal occult blood, and a colonoscopy was performed. A type I neoplastic lesion classified as Group 5 was confirmed at a site 30 cm away from the anal verge, and the patient was referred for surgical treatment (Fig. 1).

Imaging study findings

Computed tomography findings

Clips indicating the tumor site were found in the descending colon. No findings suggested lymph node metastasis or distant metastasis. Computed tomography angiography findings showed that the inferior mesenteric artery (IMA) branched into the left colic artery (LCA) and the sigmoid arteries (S1, S2) in order (Fig. 2A).

The patient was diagnosed with descending colon cancer cT2N0N0 Stage I with LCA and S1 as the dominant arteries, and a totally laparoscopic descending colectomy (D2 dissection) was scheduled.

Surgical procedure

The laparoscopic camera system used the laparoscopic surgical system 1588AIM (Stryker, USA), and the ICG used was Diagnogreen for Injection 25 mg (Daiichi-Sankyo, Japan).

Operating room setting

With the patient in the open-leg position, the laparoscopic camera port was inserted into the umbilical region by the open method. Then, 5-mm ports were inserted into the left upper and lower abdomen as well as in the right upper abdomen, and a 12-mm port was inserted into the right lower abdomen. The surgery was performed with 5 ports (Fig. 2B).

Central lymph node dissection and dominant vessel treatment

As a D2 dissection was scheduled, the IMA root was not exposed, and separation was performed from the slightly cranial side of the LCA branch. The LCA

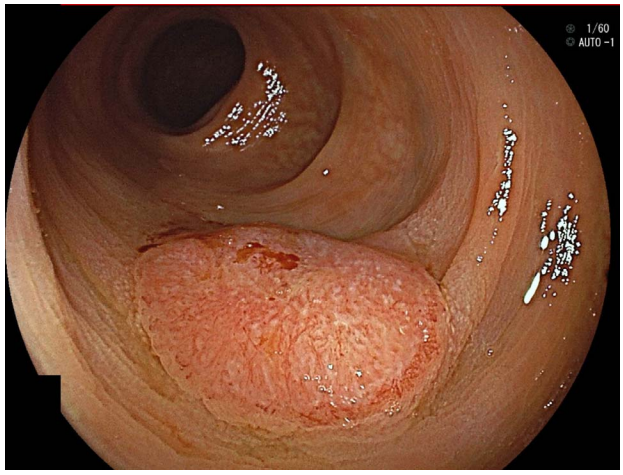

Fig. 1 Colonoscopy. Group 5. Legend: A type 1 neoplastic lesion was confirmed at a site approximately 30 cm from the anal verge, and it was diagnosed as Group 5 by biopsy.

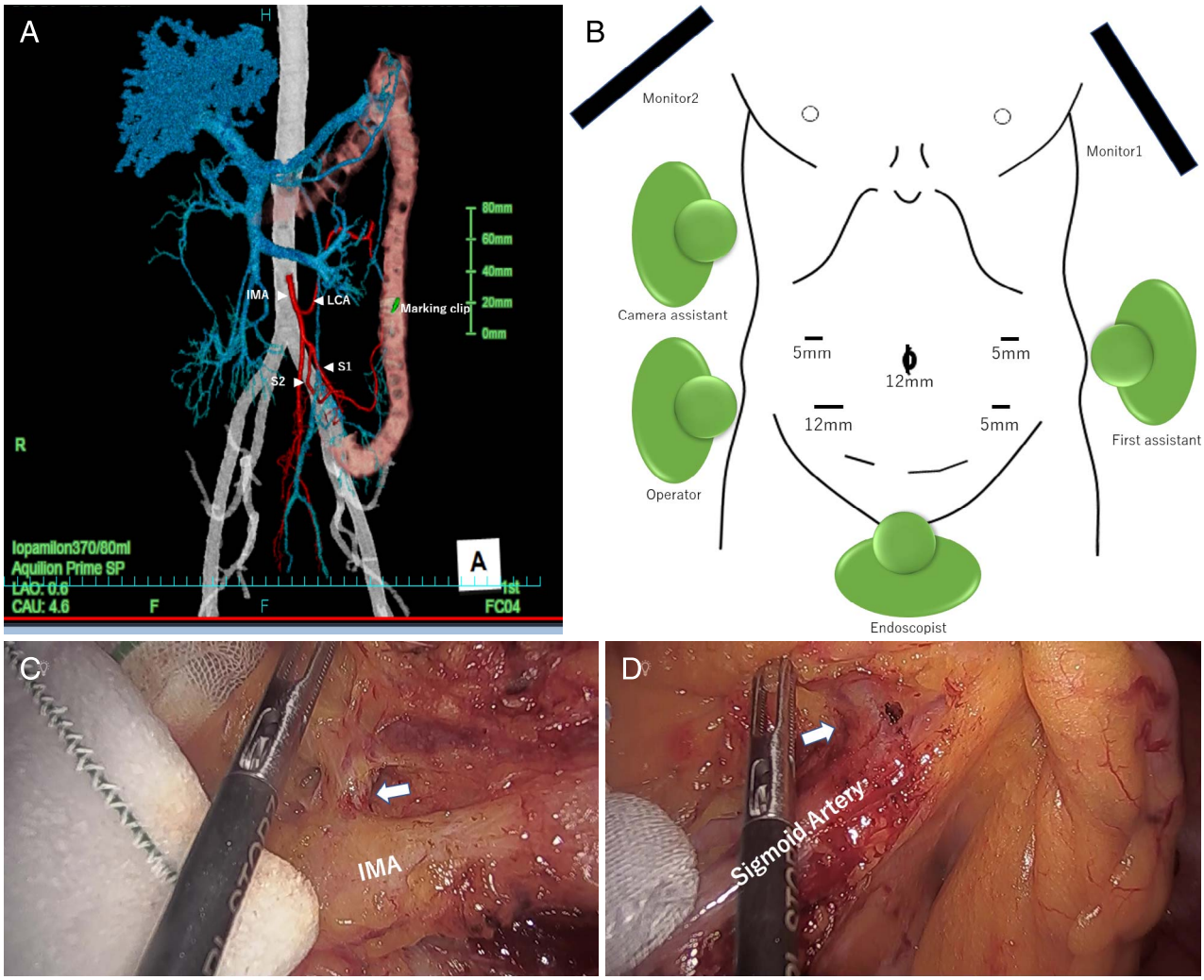

Fig. 2 Preoperative CT and intraoperative finding, and operating room setting. Legends: (A) Preoperative 3D CT Imaging. This is useful for the confirmation of IMA branching form and arcade formation. (B) With the patient in the open-leg position, the surgery is performed with 5 ports. Endoscopist is positioned between the legs, the endoscope is performed. (C) LCA branching from the IMA can be confirmed by preoperative imaging (arrow). (D) Sub-branching of the sigmoid arteries can be confirmed by preoperative imaging (arrow).

root and S1 root after S2 branching confirmed by preoperative CT angiography were identified, clipped, and dissected (Figs. 2C and 2D). Then, separation was performed toward the lateral and cranial sides along the retroperitoneal fascia.

Determination of the scheduled intestinal dissection line

The tumor was confirmed by intraoperative endoscopy, a scheduled dissection line of 10 cm removed from tumor was determined using vascular tape, and mesenteric treatment was performed by total laparoscopy (Fig. 3A).

ICG fluorescence method and intestinal dissection

After an intravenous injection of 7.5 mg ICG, blood flow was evaluated (Figs. 3B–3D), a change in the dissection line was determined to be unnecessary, and intestinal dissection was performed at the scheduled dissection line. The dorsal intestinal tract was dissected vertically to the mesenteric side so

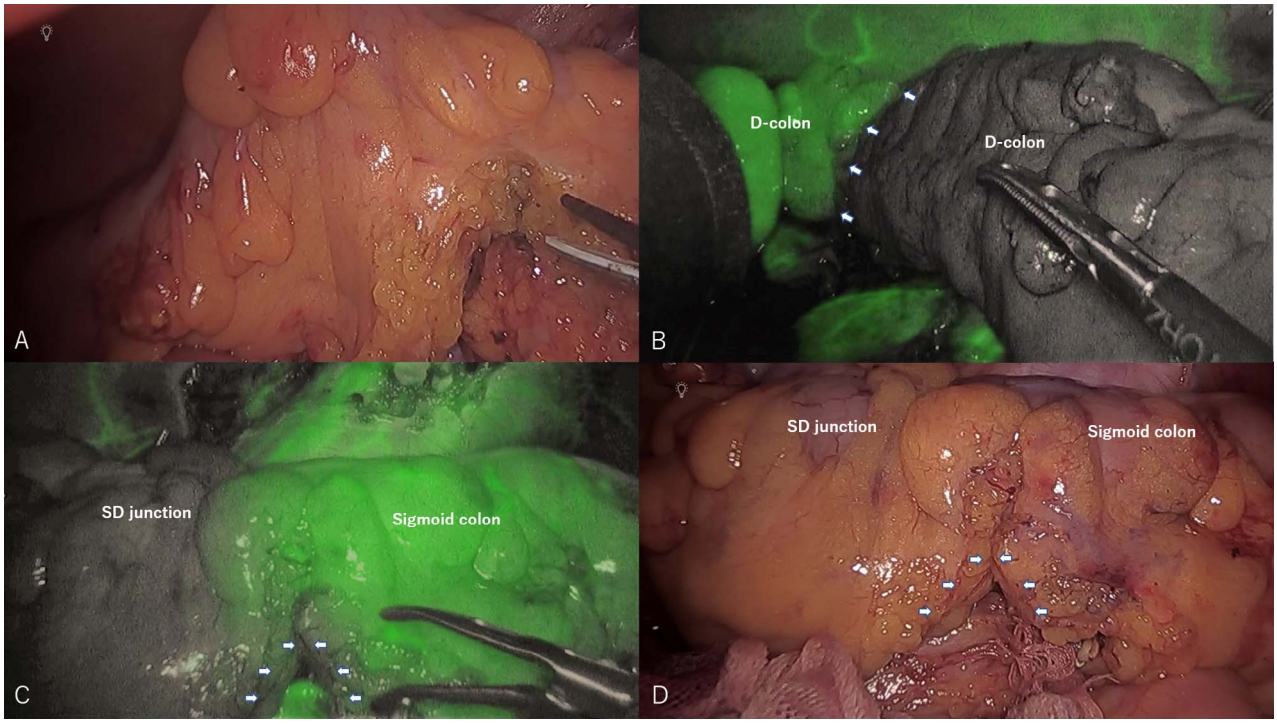

Fig. 3 Intraoperative findings. (A) Mesenteric treatment is performed in the body cavity in collaboration with surgical assistants. (B) Blood flow can be visually determined by the ICG fluorescence method (arrow) (near infrared light observation). (C) Blood flow by the mesenteric treatment site can be visually determined by the ICG fluorescence method (arrow) (near infrared light observation). (D) White light observation in the same surgical field as in (C).

that the entry hole for linear stapler could be viewed from the front.

Intracorporeal anastomosis (overlap method)

A 3-cm small incision was made in the umbilical region, and the resected specimen was removed. After re-pneumoperitoneum, an entry hole was created at the position where the dorsal intestinal tract was 90° and the anal intestinal tract was 180° against the mesenteric adhesion. Intracorporeal anastomosis was then performed using the overlap method and a linear stapler (Figs. 4A and 4B).

Closure of entry hole (Figs. 4C and 4D)

The entry hole was visible from the front, and it was closed with running suture using V-Loc (Medtronic, Japan). The defective portion of the mesentery was not closed, intraperitoneal washing and drain insertion were performed, and the incision was closed. The surgery duration was 217 minutes, and the blood loss was 37 g.

Postoperative course

The postoperative course was good, oral ingestion was initiated on postoperative day 3, and the patient was discharged on postoperative day 7. He did not experience constipation or abdominal fulness since that time.

Discussion

Recently, several reports have been published on the usefulness and long-term results of intracorporeal anastomosis in laparoscopic colectomy,[1,2] but many of them focus on right colectomy, while reports on left colectomy are relatively rare.[3] In general, intestinal anastomosis in laparoscopic left colectomy is mostly performed by extracorporeal maneuver. However, to perform an extracorporeal anastomosis as part of a left colectomy, extensive mobilization of the colon and extension of the small skin incision is necessary, which leads to additional stress in obese patients and induces mesenteric vascular injuries. Therefore, in 2017, we introduced totally laparoscopic left colectomy, which is not an indication of double stapling technique; however, there are

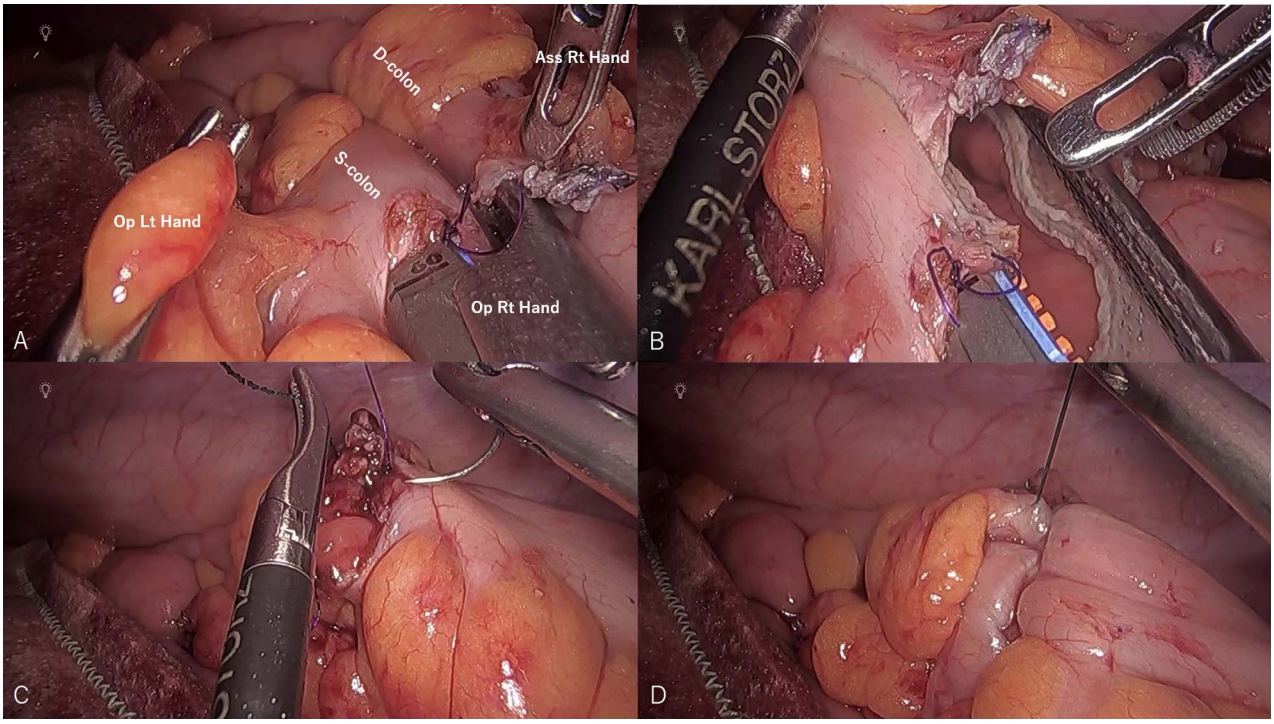

Fig. 4 Intracavitary anastomosis (overlap anastomosis). (A) Descending colon sigmoid anastomosis is performed isoperistaltically using a linear stapler. (B) Insertion hole from the front view. (C) Insertion hole is closed using V-Loc. (D) Suturing completed.

problems associated with intracorporeal anastomosis, including insufficient intestinal blood flow and technical issues. First, factors that contribute to insufficient intestinal blood flow include injuries to arcade vessels due to a mistake in the direction of mesocolon treatment and, in the case of the left colon, disruption in LCA blood flow and insufficient blood flow to the anastomotic section due to marginal arterial arch malformation. It is quite obvious that a lack of blood flow to the anastomotic region will lead to severe complications. Therefore, at our hospital, in addition to collaboration with the Department of Radiology, to perform 3D CT angiography to identify dominant arteries in all cases, we also perform preoperative simulation to evaluate the formation of the marginal arterial arch. In this case, grasping the sub-branching form of the sigmoid arteries was also useful for securing dissection and preserving residual intestinal blood flow by preserving S2 artery. Anastomotic leakage has been reported to increase perioperative mortality and affect the local recurrence rate and patient survival rate;[4,5] thus, surgeons often experience anxiety when they perform intestinal anastomosis in such cases.

We believe that the three important elements in the surgical procedure of an intestinal anastomosis are tight anastomosis, tensionless anastomosis, and sufficient blood flow to the anastomotic section. Among these factors, blood flow is very important to avoid anastomotic leakage.[6] Thus far, surgeons have determined intestinal blood flow during surgeries using various methods, but it has been reported that the risk of anastomotic leakage cannot be accurately evaluated in colon surgeries.[7] In this case, ICG used for blood flow navigation has the characteristic of binding with plasma protein and emitting fluorescence with a peak at approximately 840 nm by irradiating light with a wavelength of 750 to 810 nm as excitation light. Since Kudszus *et al* reported the usefulness of the ICG fluorescence method in evaluating local intestinal blood flow in colectomy in 2010,[8] it has often been reported to be useful in reducing the occurrence rate of anastomotic leakage.[9,10] As ICG has been approved pharmaceutically and is covered by insurance for vascular and tissue blood flow evaluation, navigation surgeries that evaluate local intestinal blood flow using this method also have become possible at small-scale regional hospitals such as our hospital. In this case, LCA and S1 were dissected, but S2 was

preserved, and sufficient blood flow could be preserved and confirmed in the colon 10 cm away from the tumor through preoperative simulation and intraoperative navigation. However, for ICG dose and fluorescence brightness, qualitative evaluation is currently the norm, which poses a problem. As luminance contrast was clear in intraoperative imaging, blood flow was determined to be good at sites where luminescence could be confirmed, but it is necessary to conduct further studies on quantitative evaluation in the future.

Next, there have been various reports on intracorporeal anastomosis in laparoscopic colectomy,[11] and we have previously reported anastomosis corresponding to delta-shaped anastomosis from the perspective of a tension-free procedure in Japanese. Intracorporeal anastomosis has the advantage of being able to reduce invasiveness such as parietal destruction, but it has some technical issues, including the possibility of an error, a misleading measurement of the length of the dissected intestinal tract, contamination of intestinal contents, and the possibility of cancer cell dispersion in cases of advanced cancer. In addition, the complexity and degree of difficulty of the surgical procedure are inevitably higher. In our case, the distance was measured using vascular tape, the length of which had been measured in advance; the intestinal contents were suctioned with the intraoperative endoscope; and the intestinal tract was not opened until intestinal dissection. Thus, contamination and dispersion did not pose a problem. Between intracorporeal anastomosis and extracorporeal anastomosis for right-sided colon cancer, intracorporeal anastomosis has often been reported to be superior from the perspectives of pain, hospitalization duration, and recovery of intestinal peristalsis, but its operation duration is significantly longer.[12] In our case, approximately 45 minutes was required for the series of procedures including mesenteric treatment, ICG evaluation, intestinal dissection, specimen removal, and intracorporeal anastomosis. Therefore, in addition to the direction of intestinal dissection and hand-eye coordination, the technique and coordination of the surgeon and the assistants and endoscopist are also important.

For surgeons, the combination of preoperative simulation and intraoperative navigation through 3D CT angiography and ICG fluorescence enables the visual confirmation of blood flow. This provides a substantial sense of security and greatly reduces the intraoperative stress of the surgeons, which is one of the three elements required for securing an anastomosis. Preoperative simulation and intraoperative navigation are thought to enable safe and accurate intestinal dissection and anastomosis in the body cavity in laparoscopic left colectomy cases.

Conclusion

We experienced an intracorporeal anastomosis in totally laparoscopic colectomy using preoperative simulation and intraoperative navigation. It is important for surgeons to not only improve their own technique but also coordinate with assistants and endoscopists. Nevertheless, the use of preoperative simulation and intraoperative navigation may reduce surgeons' intraoperative stress and enable safe and accurate intestinal dissection and intracorporeal anastomosis, especially at places such as regional hospitals.

Acknowledgments

The authors report no conflicts of interest.

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