Laparoscopic surgery for colon cancer with intestinal malrotation in adults: Two case reports and review of literatures in Japan

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ABSTRACT

INTRODUCTION: Intestinal malrotation is a congenital anomaly, and its occurrence in adults is rare. Colon cancer with intestinal malrotation is far more rare. We herein report two cases of colon cancer with intestinal malrotation treated with laparoscopic surgery and reviewed the literatures in Japan.

PRESENTATION OF CASES: Case 1 involved a 78-year-old man. Abdominal enhanced computed tomography (CT) showed that the tumor was located in the sigmoid colon. Intraoperatively, the cecum and ascending colon were located along the midline and the small intestine occupied the right side of the abdomen. The tumor was located in the cecum, and the patient was diagnosed with cecal cancer with intestinal malrotation. We performed laparoscopy-assisted ileocolic resection. Case 2 involved a 81-year-old man. Colonoscopy revealed a laterally spreading tumor in the cecum. Intraoperatively, the position of the small intestine and the ascending colon was similar to case 1, and Ladd’s band was found in front of the duodenum. Thus, we diagnosed the patient with a laterally spreading cecal tumor with intestinal malrotation and performed laparoscopy-assisted ileocolic resection.

DISCUSSION: A review of the literature revealed 49 cases of colon cancer with intestinal malrotation and laparoscopic surgery performed at 30.6%. If laparoscopic mesenteric excision for colon cancer with intestinal malrotation is unsafe because of the abnormalities of the artery, mesenteric excision should be performed outside the body.

CONCLUSION: If the intestinal malrotation is diagnosed preoperatively, 3D-CT angiography should be used to reveal the vascular anatomic anomalies for safe performance of laparoscopic surgery.

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1. Introduction

Intestinal malrotation is a congenital anomaly that may cause intestinal obstruction or midgut volvulus in infants. The diagnosis of intestinal malrotation in adults is rare because most patients remain asymptomatic.

The incidence of colorectal cancer has gradually increased. In 2016 in Japan, this cancer was ranked as the second and fourth most common type among women and men, respectively [1]. The laparoscopic approach for colon cancer has recently become a practical technique, but the optimal surgical procedure for treatment of colon cancer with intestinal malrotation has not been established because of the rarity of intestinal malrotation.

We herein report two cases of laparoscopic surgery for colon cancer with intestinal malrotation in adults and reviewed the literatures in Japan.

This case report is compliant with the SCARE Guidelines [2].

2. Presentation of cases

2.1. Case 1

A 78-year-old man visited our clinic because of constipation. Colonoscopy revealed a type II tumor located 50 cm from the anal verge (Fig. 1A). Abdominal enhanced computed tomography (CT) showed that the tumor had thick walls and was located in the center of the abdomen without lymph node swelling or metastatic lesions. From these findings, we diagnosed the patient with sigmoid colon cancer preoperatively. Intestinal malrotation was not suspected preoperatively, but a subsequent review of the imaging study demonstrated that the superior mesenteric vein (SMV) was located on the left side of the superior mesenteric artery (SMA) (Fig. 2A). We scheduled laparoscopy-assisted sigmoid colectomy. Intraoperative examination revealed that the small intestine was

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occupied the right side of the abdomen. The ileocecal region was located along the midline of the abdomen, and the marking for the tumor was found in the ascending colon. The ascending colon and cecum were not fixed with the retroperitoneum, and the ligament of Treitz could not be clearly identified. The patient was diagnosed with cecal cancer with intestinal malrotation (nonrotation type) (Fig. 3A, B). Laparoscopic mesenteric excision was considered unsafe because of the vascular and lymphatic anomalies. After mobilization of the ascending colon from the transverse colon, ileocecal region take out outside body from umbilical wound and mesenteric excision was performed outside the body. Because of the abnormalities of the artery, it was unsafe to perform right hemicolecotomy with D3 lymph node dissection. Finally, we performed the ileocecal resection with D1 lymph node dissection. We considered D1 lymph node dissection was not adequate onco logically. Histopathological examination revealed well-differentiated tubular adenocarcinoma of the cecum infiltrating the subserosal layer without lymph node metastasis (pT3N0M0, pStageIIA). Postoperative adjuvant chemotherapy was not performed and he has followed without recurrence for 5 years.

2.2. Case 2

A 81-year-old man visited another hospital because of fecal occult blood. Colonoscopy revealed a laterally spreading tumor in the cecum (Fig. 1B). Abdominal enhanced CT showed that the tumor was located in the center of the abdomen. No lymph node swellings or metastases were present. Intestinal malrotation was not suspected preoperatively. However, a retrospective review of the CT image demonstrated that the SMA was located on the left side of the SMA and that the small intestine and colon occupied the right and left sides of the abdominal cavity (Fig. 2B). These signs were identical to those in Case 1. We scheduled laparoscopy-assisted ileocecal resection. Intraoperative examination revealed that the omentum was extensively adhered to the right wall of the abdomen. Upon peeling off this adhesion, the small intestine was found to occupy the right side of the abdomen. A further search of the intraperitoneal region showed that Ladd’s bands were lying in front of the duodenojejunal junction, and the duodenum (which was free from the retroperitoneum) passed straight down to join the jejunum to right upper quadrant (Fig. 3C, D). We diagnosed the patient with a laterally spreading cecal tumor with intestinal malrotation (nonrotation type). The adhesion between the ascending colon and transverse colon was exfoliated by sharp dissection. After mobilization of the ascending colon, lymphadenectomy was performed outside the body because of the vascular and lymphatic anomalies. Finally, we performed ileocecal resection with D1 lymph node dissection. Histopathological examination revealed well-differentiated tubular adenocarcinoma of the cecum infiltrating the mucosal layer without lymph node metastasis.

3. Discussion

The midgut rotates 270° counterclockwise around the SMA and is fixed to the retroperitoneum at 4–12 weeks of fetal life. The process of rotation has been conveniently divided into three stages [3]. The first stage is essentially that of an umbilical loop with two limbs lying beside one another, the second is the stage of beginning of intestinal rotation, and the third is the stage of fixation of the intestine and fusion of its mesentery. Intestinal malrotation is defined faulty rotation with fixation of the midgut. In several reports, the various forms of intestinal malrotation has been clas-
sified [4–6]. Wang and Welch [5] classified intestinal malrotation into four types depending on the degree of rotation during the second stage of rotation: nonrotation, malrotation, reversed rotation, and paraduodenal hernia.

Intestinal malrotation can cause intestinal obstruction or midgut volvulus in infants. Approximately 64–80% of cases of intestinal malrotation present during the first few months of life [7]. The occurrence of intestinal malrotation in adults is rare because most patients remain asymptomatic. Thus, most cases of intestinal malrotation are incidentally found during abdominal examinations or operations. Moreover colon cancer with intestinal malrotation is very rare.

From 1974 to 2017 in Japan, 49 cases of colon cancer with intestinal malrotation, including our cases, were identified [8–17] (Table 1). However, a search of PubMed revealed seven cases of colon cancer with intestinal malrotation worldwide [11,18]. In the review of the literatures in Japan, the median patient age was 64 years (range, 22–88 years), and 27 patients were male. The tumors were located at the appendix in 1 case, cecum in 10 cases, ascending colon in 11 cases, transverse colon in 12 cases, sigmoid colon in 5 cases, descending colon in 2 cases and rectum in 9 cases. With respect to the type of intestinal malrotation, 34 (69.4%) cases were the nonrotation type, 8 (16.3%) cases were the reversed type, 5 (10.2%) cases were the malrotation type and 1 (2%) case was the paraduodenal hernia. Wang and Welch [5] reported that the malrotation type is the most common of the four types. Intestinal malrotation was diagnosed at surgery in 9 cases, by barium enema in 18 cases, by abdominal CT in 18 cases, by three-dimensional CT (3D-CT) angiography in 6 cases, by 3D-CT colonography in 3 cases, by virtual colonoscopy in 1 case, by multidetector-row CT in 1 case, and by sodium diatrizoate enema in 1 case. Although most cases of intestinal malrotation in adults were diagnosed by barium enema or during surgery until 2005, the development of imaging technology has increased the rate of diagnosis of intestinal malrotation by abdominal CT. At present, CT is one of the most useful diagnostic modalities for intestinal malrotation in adults. Nehra and Goldstein [19] also reported that the diagnostic modality for intestinal malrotation was switched to abdominal CT from upper gastrointestinal series. Conversely, the tumor location is mostly diagnosed by barium enema and colonoscopy.

With respect to the surgical approach, open surgery was performed in 34 of 49 cases; laparoscopic surgery was performed in 15 (30.6%) cases. Until 2012, laparoscopic surgery was performed in only 2 of 27 (7.4%) cases. After 2012, however, laparoscopic surgery was performed 13 (59.1%) of 22 cases. This tendency is because laparoscopic surgery for colon cancer is becoming more widely performed, and the quality of this procedure is advancing. Although conventional laparoscopic colorectal cancer surgery with mesenteric excision is frequently and safely performed in the abdominal cavity, mesenteric excision outside the abdominal cavity was performed in 8 (53.3%) of 15 cases in a review of the literatures. Because intestinal malrotation is associated with abnormalities of the artery [16,20], it is difficult to safely perform laparoscopic lymph node dissection inside the abdominal cavity. A thorough preoperative understanding of the anatomical anomalies is important, especially vascular anomalies, for safe performance of mesenteric excision inside the abdominal cavity. In our review, three of four cases of malrotation diagnosed by 3D-CT angiography involved lymph node dissection inside the abdominal cavity. Therefore we think 3D-CT angiography is a useful modality for safe laparoscopic surgery in patients with colon cancer with intestinal malrotation.

4. Conclusion

The laparoscopic approach for colon cancer with intestinal malrotation has not been established. The present review of the Japanese literature clearly showed that laparoscopic lymphadenectomy for colon cancer with intestinal malrotation is not feasible. If the intestinal malrotation is diagnosed preoperatively, 3D-CT
| Case | Author | Publish | Age | Sex | Location | Type | Diagnosis of Intestinal Malrotation | Diagnosis of Tumor Location | Operation | Mesenteric Excision | Histopathology | Stage(UICC7th) |
|------|--------|---------|-----|-----|----------|------|-------------------------------------|----------------------------|-----------|-------------------|---------------|---------------|
| 1    | Hitatsuka 1974  | 47 F  | cecum  | nonrotation | operation | operation | open | unknown | tub1 | unknown |
| 2    | Shimamaki 1968  | 73 M  | rectum | nonrotation | barium enema | barium enema | open | tub2 | T2,N0,M0,StageIIB |
| 3    | Osbata 1970  | 68 M  | rectum | nonrotation | differentiated adenocarcinoma | barium enema | open | tub2 | T3,N2,M0,StageIVA |
| 4    | Isogai 1995  | 77 F  | rectum | nonrotation | barium enema | barium enema | open | tub2 | T2,N0,M0,StageIIB |
| 5    | Yokota 1995  | 66 M  | rectum | nonrotation | operation | barium enema | open | tub2 | T4b,N1,M0,StageIBC |
| 6    | Ogawa 1997  | 69 F  | Malrotation | unknown | operation | open | unknown | tub1 | unknown |
| 7    | Sounaka 1997  | 22 M  | ascending colon | nonrotation | operation | operation | open | tub1 | T4a,N3,M0,StageIVB |
| 8    | Kinoue 1998  | 57 F  | rectum | nonrotation | barium enema | barium enema | open | tub2 | T3,N0,M0,unknown |
| 9    | Kinoue 1998  | 62 F  | Malrotation | unknown | operation | open | unknown | tub2 | T4a,N0,M0,StageIIB |
| 10   | Nagata 1998  | 72 M  | rectum | reversed rotation | barium enema | colonoscopy | open | tub2 | T3,N0,M0,unknown |
| 11   | Tanimura 1999  | 58 M  | Malrotation | nonrotation | barium enema | barium enema | open | tub2 | T4a,N3,M0,StageIVB |
| 12   | Sato 2001  | 60 M  | appendix | nonrotation | barium enema | barium enema | open | tub2 | T3,N1,M0,StageIBB |
| 13   | Sasaki 2003  | 71 F  | cecum | Malrotation | colonoscopy | colonoscopy | open | tub2 | T3,N0,M0,StageIIBA |
| 14   | Fujita 2004  | 55 F  | sigmoid colon | nonrotation | barium enema | colonoscopy | open | tub2 | T3,N0,M0,StageIIBA |
| 15   | Uchida 2004  | 57 M  | transverse colon | nonrotation | sodium diatrizate enema | colonoscopy,selective | open | tub1 | T3,N0,M0,StageIIBA |
| 16   | Oki 2005  | 56 M  | ascending colon | nonrotation | barium enema | barium enema | open | tub1 | T1a,X1,H,StageIVA |
| 17   | Tonomatsu 2005  | 81 F  | ascending colon | nonrotation | barium enema | colonoscopy | open | tub1 | T3,N2,M1a,X1,H,StageIVA |
| 18   | Sakaizawa 2007  | 84 M  | transverse colon | nonrotation | barium enema, abdominal CT | abdominal CT | open | tub2 | T4b,N1,M0,StageIIB |
| 19   | Yamamoto 2007  | 63 F  | rectum | nonrotation | barium enema, MDCT | colonoscopy | laparoscopic | open | tub1 | T2,N0,M0,StageI |
| 20   | Seki 2008  | 88 F  | transverse colon | nonrotation | operation | colonoscopy | laparoscopic | unknown | tub2 | T3,N0,M0,StageIIB |
| 21   | Nakajima 2009  | 71 F  | sigmoid colon | nonrotation | colonoscopy | colonoscopy | laparoscopic | inside body | tub2 | T3,N0,M0,StageIIB |
| 22   | Kobayashi 2009  | 60 M  | ascending colon | reversed rotation | colonoscopy | colonoscopy | laparoscopic | outside body | tub2 | T3,N0,M0,StageI |
| 23   | Itanii 2009  | 61 M  | transverse colon | nonrotation | abdominal CT | abdominal CT | open | tub2 | T3,N1,M0,StageIBB |
| 24   | Takahashi 2009  | 84 M  | ascending colon | nonrotation | barium enema, abdominal CT | colonoscopy | laparoscopic | inside body | tub2 | T3,N1,M0,StageIBB |
| 25   | Ino 2010  | 67 F  | transverse colon | nonrotation | virtual colonoscopy | colonoscopy | open | tub1 | T3,N1,M0,StageIBB |
| 26   | Fukuhara 2010  | 76 F  | cecum | nonrotation | operation | colonoscopy | laparoscopic | open | tub1 | T3,N1,M0,StageIBB |
| 27   | Kojima 2011  | 73 M  | cecum | reversed rotation | colonoscopy | colonoscopy | laparoscopic | open | tub2 | unknown |
| 28   | Tawahashi 2012  | 53 F  | sigmoid colon | nonrotation | abdominal CT | colonoscopy | open | tub1 | T3,N1,M0,StageIBB |
| 29    | Sekizawa 2012  | 56 F  | rectum | reversed rotation | abdominal CT | colonoscopy | open | tub2 | T4b,N1,M0,StageIBC |
| 30  | Toba 2012  | 79 M  | Malrotation | nonrotation | 3D-CT angiography | colonoscopy | laparoscopic | outside body | tub1 | T2,N0,M0,StageI |
| 31  | Morimoto 2012  | 57 M  | cecum | reversed rotation | abdominal CT | colonoscopy | laparoscopic | unknown | tub2 | T3,N2,M0,StageIBC |
| 32  | Suzuki 2013  | 53 M  | Malrotation | nonrotation | operation | laparoscopic | outside body | tub2 | T3,N0,M0,StageIIB |
| 33  | Maeda 2013  | 56 M  | transverse colon | nonrotation | 3D-CT colonography | 3D-CT colonography | laparoscopic | open | tub2 | T3,N0,M0,StageI |
| 34  | Hirano 2013  | 82 F  | transverse colon | reversed rotation | abdominal CT, barium enema | colonoscopy | laparoscopic | outside body | tub2 | T3,N0,M0,StageI |
| 35  | Hitano 2013  | 68 F  | Malrotation | descending colon | barium enema | colonoscopy | laparoscopic | unknown | tub1 | T3,N0,M0,StageI |
| 36  | Takahashi 2014  | 53 F  | ascending colon | malrotation | barium enema, abdominal CT, 3D-CT colonography | barium enema | laparoscopic | outside body | tub2 | T3,N1,M0,StageIBB |
| 37  | Fujii 2014  | 73 F  | cecum | nonrotation | abdominal CT | barium enema | open | tub1 | T3,N0,M0,StageI |
| 38  | Enomoto 2014  | 48 M  | ascending colon | nonrotation | abdominal CT | barium enema | laparoscopic | inside body | tub2 | T3,N0,M0,StageI |
| 39  | Kuoda 2014  | 64 F  | transverse colon | nonrotation | abdominal CT | barium enema | laparoscopic | inside body | tub2 | T4a,N1,M0,StageIBB |
| 40  | Motoda 2015  | 57 F  | cecum | nonrotation | 3D-CT angiography | colonoscopy | laparoscopic | unknown | tub2 | T3,N1,M0,StageIBB |
| 41  | Kurohara 2015  | 54 F  | transverse colon | nonrotation | abdominal CT, 3D-CT angiography | colonoscopy | laparoscopic | inside body | tub2 | T3,N0,M0,StageI |
| 42  | Kobata 2015  | 82 M  | Malrotation | barium enema | colonoscopy | open | tub1 | T4a,N2,M0,StageIVB |
| 43  | Ohsawa 2016  | 75 M  | Malrotation | reversed rotation | colonoscopy,barium enema | colonoscopy | laparoscopic | unknown | tub1 | T3,N1,M0,StageI |
| 44  | Shimizu 2016  | 77 M  | sigmoid colon | reversed rotation | 3D-CT angiography,3D-CT colonography | colonoscopy,barium enema | laparoscopic | unknown | tub2 | T3,N1,M0,StageIBB |
| 45  | Nakayama 2016  | 63 M  | Malrotation | nonrotation | colonoscopy | colonoscopy | laparoscopic | open | tub2 | T4b,N0,M0,StageIBC |
| 46  | Motoki 2016  | 66 M  | Malrotation | nonrotation | colonoscopy | colonoscopy | laparoscopic | unknown | tub2 | T2,N0,M0,StageI |
| 47  | Nichida 2017  | 57 M  | sigmoid colon | nonrotation | colonoscopy | laparoscopic | laparoscopic | open | tub2 | T3,N0,M0,StageI |
| 48  | Kimura 2017  | 54 F  | sigmoid colon | paraduodenal hernia | 3D-CT angiography,abdominal CT | colonoscopy | laparoscopic | inside body | tub2 | T3,N0,M0,StageI |

**ACCESS**

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angiography should be used to reveal the vascular anatomic anomalies for safe performance of laparoscopic surgery.

**Conflicts of interest**

The authors declare that they have no competing interests.

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**Ethical approval**

This paper was not a research study, so ethical approval not required.

**Consent**

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

**Author contribution**

KT made substantial contribution to conception and drafted the manuscript. KN conducted a literature search and made the contribution for acquisition of data. KT, KN, TS, KY performed the operation. KT, KN, KY and MK reviewed the manuscript and gave final approval for publication. KT was revising it critically for important intellectual content. All authors read and approved the final manuscript.

**Guarantor**

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