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Case Report

Preoperative Assessment of Vascular Anatomy by Multidetector Computed Tomography Before Laparoscopic Colectomy for Transverse Colon Cancer: Report of a Case

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Although the safety of laparoscopic surgery for colon cancer has been reported in many randomized controlled trials, concerns about the difficulty of surgery for transverse colon cancer has not been fully resolved, mainly because of the variation in the vascular anatomy of mesenteric vessels, which leads to difficulty in determining the optimal operative procedure and the extent of lymph node dissection. We present the case of a patient with transverse colon cancer who underwent laparoscopic surgery after preoperative assessment using a combination of endoscopic clipping and three-dimensional computed tomography angiography (3DCTA). A 68-year-old man was diagnosed with transverse colon cancer, and laparoscopic surgery has been planned. 3DCTA showed right-middle and left-middle colic arteries arising independently from the superior mesenteric artery. The relationship between the clip and vessels showed that the right-middle colic artery was the feeding artery of the tumor. Operative findings were consistent with 3DCTA findings, and transverse colectomy with lymph node dissection was successfully performed.

Key words: Multidetector computed tomography – Transverse colon cancer – Laparoscopic surgery

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Laparoscopic surgery is generally a feasible and safe alternative to open surgery, with such potential benefits as early postoperative recovery, decreased postoperative pain, and shorter hospitalization.[1–3] However, the impact of several factors, such as obesity and transverse colon cancer, on the outcomes of laparoscopic colectomy poses some technical problems.[4–7] Patients with transverse colon cancer were often excluded from previous randomized controlled trials because it was difficult to determine the appropriate extent of lymph node dissection, and because the technical difficulties depend on the identification and lymph node dissection around the middle colic vessels, which have a variable anatomy.[5–9]

The recent development of multidetector computed tomography (MDCT) has made it possible to perform three-dimensional CT angiography (3DCTA). Many studies have shown that MDCT is an accurate modality for imaging the anatomy of visceral arteries and veins.[10–12] A recent study found that preoperative assessment of perigastric vessels using 3DCTA significantly reduced intraoperative blood loss in patients undergoing laparoscopic gastric surgery.[13] Furthermore, Mari *et al*[14] conducted a randomized controlled trial and reported that viewing 3DCTA of mesenteric vessels before or during colorectal surgery reduced operative time and episodes of difficult identification of correct anatomy, as well as the incidence of intraoperative and postoperative complications related to difficult identification of mesenteric vessel anatomy. However, only standardized right or left hemicolectomy and anterior rectal resections were enrolled in the study, and the clinical usefulness of 3DCTA in patients undergoing transverse colectomy has not yet been elucidated. To achieve precise lymph node dissection in patients with midportion transverse colon cancer, it is very important to identify the feeding artery of the tumor. However, the many variations of tumor location and vascular anatomy make this difficult during laparoscopic transverse colectomy. We herein report on a patient with transverse colon cancer, the tumor size of which was too small to detect in usual CT, who underwent preoperative assessment of tumor location and vascular anatomy using a combination of endoscopic clipping and 3DCTA. The findings of this preoperative investigation enabled us to perform successful laparoscopic transverse colectomy with adequate lymph node dissection.

Fig. 1 Barium enema showing a type 2 tumor in the mid–transverse colon.

Case Presentation

A 68-year-old man was referred to his local hospital for investigation of constipation. He had a history of diabetes mellitus but no previous operation or significant family history. His body mass index was 22.5 kg/m^2. Colonoscopy showed transverse colon cancer, and he was referred to our institution for further investigation and treatment.

Barium enema showed a 3 cm diameter tumor in the midtransverse colon (Fig. 1). Histopathologic examination of a colonoscopic biopsy specimen showed moderately differentiated adenocarcinoma. During colonoscopy, his tumor was marked with a clip (Fig. 2). Contrast-enhanced MDCT was performed to assess distant and lymph node metastasis as well as the vascular anatomy of the mesocolon and the feeding artery of the tumor. Reconstructed 3DCTA images showed right-middle and left-middle colic arteries arising independently from the superior mesenteric artery, as well as 1 ileocolic artery and 2 right colic arteries arising from the superior mesenteric artery (Fig. 3). The relationship between the clip and the vessels identified the right-middle colic artery as the feeding artery of the tumor.

Preoperative diagnosis was made as transverse colon cancer, T2 N1 M0 in TNM classification. Laparoscopic colectomy was performed. Operative findings showed the ileocolic artery crossing posterior to the superior mesenteric vein, and 2 right colic arteries, one crossing anterior and the other poste-

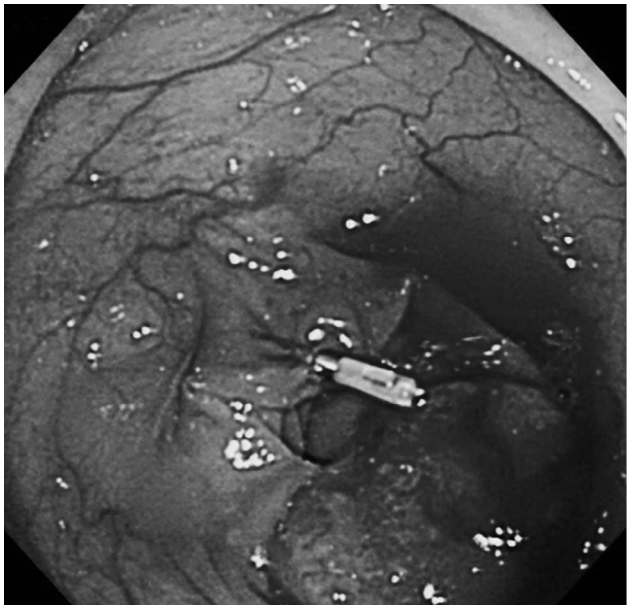

Fig. 2 Endoscopic findings, with a marking clip next to the tumor.

rior to the superior mesenteric vein (Fig. 4). The tumor was located in the mid–transverse colon, and the right-middle colic artery, which arose directly from the superior mesenteric artery, was the feeding artery in close proximity to the tumor. The left-middle colic artery arose independently from the superior mesenteric artery and was not feeding the tumor. The operative findings were consistent with the 3DCTA findings. Transverse colectomy was successfully performed with sufficient lymph node dissection and central ligation of the right-middle colic artery, compliant with the Japanese Classification of Colorectal Carcinoma.[15] The total blood loss was 90 mL and operative time was 228 minutes. A total of 23 lymph nodes were harvested, of which 2 had metastasis.

The postoperative course was uneventful and the patient was discharged on the seventh postoperative day. There is no sign of recurrence within 2 years of follow-up.

Discussion

Several studies have demonstrated the clinical usefulness of 3DCTA for evaluating vascular anatomy.[10–14] 3DCTA has been used for diagnosing disorders of the aorta and its major branches[16,17] and has been reported to be a useful alternative to conventional angiography for the preoperative assessment of candidates for liver and kidney transplantation.[18] Considering that the effectiveness of 3DCTA has been reported to guide laparoscopic gastric cancer surgery and laparoscopic colectomy,[13,14,19–21] we decided to use this modality to guide transverse colectomy. Spasojevic *et al*[22] recently reported that 3DCTA demonstrated the anatomic relationships between the right colic artery, ileocolic artery, and superior mesenteric vein at least as well as postmortem anatomic studies. Mari *et al*[14] have reported the usefulness of preoperative assessment

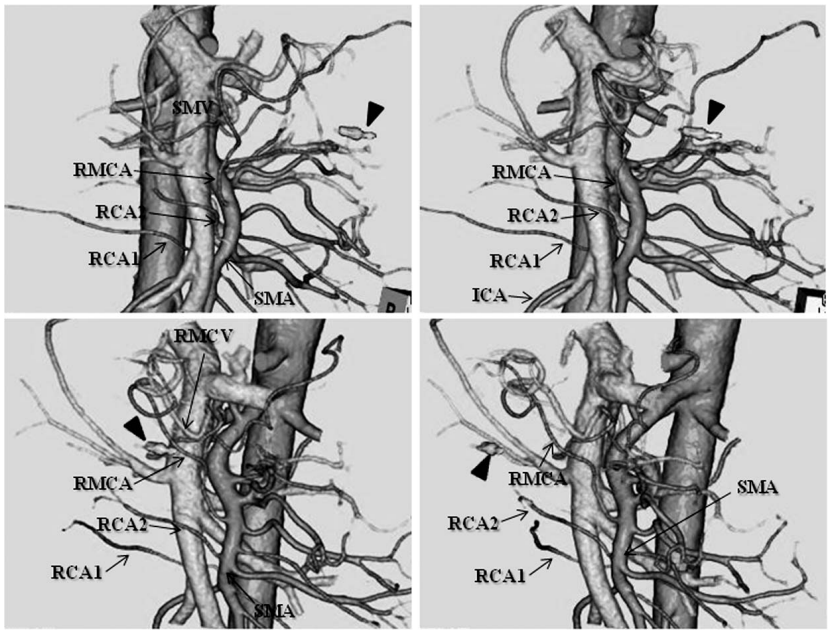

Fig. 3 Fused image from 3DCT arteriography and venography, clearly showing the relationship between the tumor, marked by the endoscopic clip (arrowhead), and the middle colic vessels. (a) Right anterior oblique view. (b) Front view. (c) Left anterior oblique view. (d) Lateral view. The right-middle and left-middle colic arteries arise independently from the superior mesenteric artery. Two right colic arteries are also visualized. SMA indicates superior mesenteric artery; SMV, superior mesenteric vein; RCA1, right colic artery 1; RCA2, right colic artery 2; RMCA, right-middle colic artery; and RMCV, right-middle colic vein.

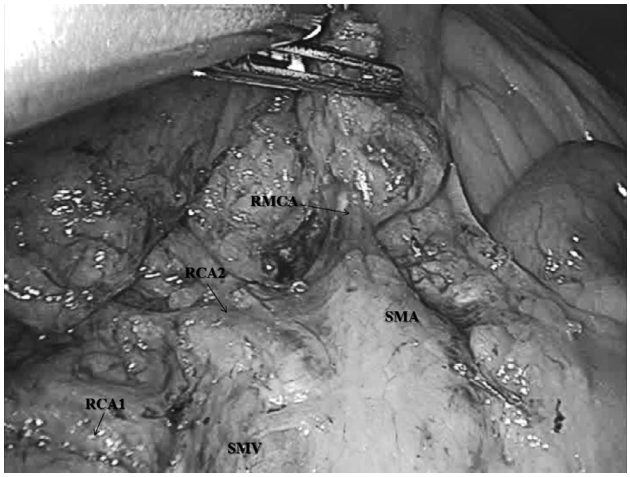

Fig. 4 The operative findings were consistent with the preoperative 3DCTA findings.

of 3DCTA in standardized colorectal surgery, but transverse colectomy was excluded.

When analyzing the imaging results, we paid particular attention to identifying the feeding artery to the transverse colon cancer, to enable lymphadenectomy along the course of the feeding artery. Laparoscopic colectomy is a challenging procedure because of variations in tumor location and vascular anatomy, especially in obese patients. The procedure we present here, using a combination of endoscopic clipping and MDCT, can identify tumor location and evaluate vascular anatomy, including identification of the feeding artery. In this case, preoperative assessment of the arteries and veins using 3DCTA helped to achieve safe ligation of the vessels and dissection of the lymph nodes. The courses of the right and middle colic vessels on 3DCTA were consistent with the operative findings. 3DCTA showed the right-middle and left-middle colic arteries arising independently from the superior mesenteric artery, and also 1 ileocolic artery and 2 right colic arteries arising from the superior mesenteric artery. Because the tumor size was too small to detect by CT, we used the clip to detect the precise location of the tumor, and we identified the right-middle colic artery as the feeding artery of the tumor, which enabled us to perform adequate lymph node dissection. Compared with conventional angiography, 3DCTA also has advantages in terms of convenience, safety, and cost-effectiveness. Our procedure, using a combination of endoscopic clipping and MDCT, enabled the surgeon to operate efficiently. Recently, careful patient selection, in order to allow a surgeon to build experience in the early part of his or her learning curve for laparoscopic colectomy, has also been reported to be important,[23] and our procedure may also help to shorten the learning curve of laparoscopic surgery, especially in patients who have other risk factors, such as obesity.

In conclusion, our preoperative assessment for colectomy using MDCT is feasible and safe, and it seems to have potential benefits, especially in cases where it is difficult to identify vascular anatomy and feeding arteries intraoperatively, such as in transverse colon cancer or obesity cases. Additionally, using a combination of endoscopic clipping may be useful in small tumors that are difficult to detect by CT. Further prospective studies are needed to establish the usefulness of this method.

References

1. Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;**350**(20):2050–2059
2. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM *et al*. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005;**365**(9472):1718–1726
3. Hewett PJ, Allardyce RA, Bagshaw PF, Frampton CM, Frizelle FA, Rieger NA *et al*. Short-term outcomes of the Australasian randomized clinical study comparing laparoscopic and conventional open surgical treatments for colon cancer: the ALCCaS trial. *Ann Surg* 2008;**248**(5):728–738
4. Makino T, Shukla PJ, Rubino F, Milsom JW. The impact of obesity on perioperative outcomes after laparoscopic colorectal resection. *Ann Surg* 2012;**255**(2):228–236
5. Schlachta CM, Mamazza J, Poulin EC. Are transverse colon cancers suitable for laparoscopic resection? *Surg Endosc* 2007; **21**(3):396–399
6. Akiyoshi T, Kuroyanagi H, Fujimoto Y, Konishi T, Ueno M, Oya M *et al*. Short-term outcomes of laparoscopic colectomy for transverse colon cancer. *J Gastrointest Surg* 2010;**14**(5):818–823
7. Yamamoto M, Okuda J, Tanaka K, Kondo K, Tanigawa N, Uchiyama K. Clinical outcomes of laparoscopic surgery for advanced transverse and descending colon cancer: a single-center experience. *Surg Endosc* 2012;**26**(6):1566–1572
8. Spasojevic M, Stimec BV, Gronvold LB, Nesgaard JM, Edwin B, Ignjatovic D. The anatomical and surgical consequences of right colectomy for cancer. *Dis Colon Rectum* 2011;**54**(12):1503–1509
9. Sakorafas GH, Zouros E, Peros G. Applied vascular anatomy of the colon and rectum: clinical implications for the surgical oncologist. *Surg Oncol* 2006;**15**(4):243–255

10. Foley WD, Mallisee TA, Hohenwalter MD, Wilson CR, Quiroz FA, Taylor AJ. Multiphase hepatic CT with a multirow detector CT scanner. *AJR Am J Roentgenol* 2000;**175**(3):679–685
11. Kawamoto S, Montgomery RA, Lawler LP, Horton KM, Fishman EK. Multidetector CT angiography for preoperative evaluation of living laparoscopic kidney donors. *AJR Am J Roentgenol* 2003;**180**(6):1633–1638
12. Holden A, Smith A, Dukes P, Pilmore H, Yasutomi M. Assessment of 100 live potential renal donors for laparoscopic nephrectomy with multi-detector row helical CT. *Radiology* 2005;**237**(3):973–980
13. Natsume T, Shuto K, Yanagawa N, Akai T, Kawahira H, Hayashi H *et al*. The classification of anatomic variations in the perigastric vessels by dual-phase CT to reduce intraoperative bleeding during laparoscopic gastrectomy. *Surg Endosc* 2011; **25**(5):1420–1424
14. Mari FS, Nigri G, Pancaldi A, De Cecco CN, Gasparrini M, Dall'oglio A *et al*. Role of CT angiography with three-dimensional reconstruction of mesenteric vessels in laparoscopic colorectal resections: a randomized controlled trial. *Surg Endosc* 2013;**27**(6):2058–2067
15. Japanese Society for Cancer of the Colon and Rectum. *Japanese Classification of Colorectal Carcinoma*. 2nd English ed. Tokyo, Japan: Kanehara & Co Ltd; 2009
16. Rubin GD, Dake MD, Napel SA, McDonnell CH, Jeffrey RB Jr. Three-dimensional spiral CT angiography of the abdomen: initial clinical experience. *Radiology* 1993;**186**(1):147–152
17. Galanski M, Prokop M, Chavan A, Schaefer CM, Jandeleit K, Nischelsky JE. Renal arterial stenoses: spiral CT angiography. *Radiology* 1993;**189**(1):185–192
18. Winter TC III, Freeny PC, Nghiem HV, Hommeyer SC, Barr D, Croghan AM *et al*. Hepatic arterial anatomy in transplantation candidates: evaluation with three-dimensional CT arteriography. *Radiology* 1995;**195**(2):363–370
19. Miyaki A, Imamura K, Kobayashi R, Takami M, Matsumoto J, Takada Y. Preoperative assessment of perigastric vascular anatomy by multidetector computed tomography angiogram for laparoscopy-assisted gastrectomy. *Langenbecks Arch Surg* 2012;**397**(6):945–950
20. Kim HS, Han HY, Choi JA, Park CM, Cha IH, Chung KB *et al*. Preoperative evaluation of gastric cancer: value of spiral CT during gastric arteriography (CTGA). *Abdom Imaging* 2001; **26**(2):123–130
21. Matsuki M, Kani H, Tatsugami F, Yoshikawa S, Narabayashi I, Lee SW *et al*. Preoperative assessment of vascular anatomy around the stomach by 3D imaging using MDCT before laparoscopy-assisted gastrectomy. *AJR Am J Roentgenol* 2004; **183**(1):145–151
22. Spasojevic M, Stimec BV, Gronvold LB, Nesgaard JM, Edwin B, Ignjatovic D. The anatomical and surgical consequences of right colectomy for cancer. *Dis Colon Rectum* 2011;**54**(12):1503–1509
23. Yamamoto M, Okuda J, Tanaka K, Kondo K, Asai K, Kayano H *et al*. Evaluating the learning curve associated with laparoscopic left hemicolectomy for colon cancer. *Am Surg* 2013; **79**(4):366–371