Variants of the middle colic vein depicted by three-dimensional computed tomography angiography before laparoscopic surgery

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Learning objectives

The purpose of this poster presentation is to show the anatomic variants of the middle colic vein (MCV) with three-dimensional computed tomography angiography (3-D CTA).
Background

The MCV passes between the layers of the transverse mesocolon, and is a landmark of the root of the transverse mesocolon [1]. The relationship between the MCV and its tributaries is complex. Although the vascular anatomy has been studied in past years, few studies have addressed the venous anatomy around the superior mesenteric vein (SMV), especially regarding the tributary of the MCV. To our knowledge, there have been few in vivo studies on the tributary of the MCV with a large number of patients.

Laparoscopic surgery is considered a minimally invasive technique, but provides only a limited view of the operative field. Furthermore, operators cannot manipulate organs and lesions directly [2], so they are required to pay more intensive attention to anatomical structures of the mesentery to identify and ligate proper vessels. In addition, to recognize the MCV could be helpful for radiologists to identify the extent of gastric and pancreatic diseases as well as colorectal diseases. Therefore, 3-D CTA plays an important role in various clinical situations. So, we performed 3-D CTA for all the patients with gastric or colorectal cancers except for those who needed emergency surgeries for obstruction or perforation, and assessed variations of the tributaries of the MCV.
Findings and procedure details

<Patients>

Between June 2010 and April 2012, 331 patients (203 men and 128 women, mean age 67 years; range, 29 - 90) scheduled for laparoscopic surgery in Kariya General Hospital were included in this study. For each patient, we performed dynamic contrast-enhanced CT and evaluated the tributary of the MCV as described in the following sections.

<Preparation>

The patients with colorectal cancer were asked to have inspection diet for two days before the examination, and to take a purgative in the evening before the examination. They were placed in a right decubitus position, and room air was insufflated through a rubber catheter (diameter: 8.5mm, Izumo-Health, Co. Ltd, Nagano, Japan) inserted into the rectum until they felt unbearable with distension. They were encouraged to keep the gas in the rectum. After the colon was inflated, the catheter was left in the rectum. Patients with intestinal obstruction due to colorectal cancer did not undergo air insufflation for risk of perforation based on a doctor's instruction. The patients with gastric cancer were asked 4-hour fasting before the examination, and to take 5.0 g of effervescent granules just before it for inflation of the stomach. Distention of the stomach or colon enabled a clear view of the courses of the surrounding arteries and veins.

<Imaging Data Acquisition and Reconstruction Protocol>

The MDCT examinations were performed with a 64-detector row CT scanner (Light Speed VCT Vision; GE Healthcare, Milwaukee, WI, USA, and Aquilion 64; Toshiba Medical Systems, Tokyo, Japan) using an automatic exposure control technique. A 20-gauge IV catheter was inserted into the right cubital vein. Scanning was performed with the following parameters: tube voltage, 120 kV; scan direction, head-to-toe for both scanners; tube rotation speed, 0.4 and 0.5 s; pitch factor, 0.984 and 0.703; collimation 64 × 0.625 mm and 64 × 0.5 mm; slice thickness, 0.5 mm; reconstruction kernel, STANDARD and FC13 for Light Speed VCT Vision and Aquilion 64, respectively.

Dynamic contrast-enhanced CT was performed using a bolus tracking technique, where a region of interest (ROI) was placed on the abdominal aorta at the level of the root of the celiac artery and the trigger threshold inside the ROI was set at 100 HU higher than the baseline. The first arterial phase scan was started immediately after the threshold was achieved after the administration of a contrast material. The second phase images were obtained 25 seconds after the first arterial phase, and the third phase images were obtained 40 and 50 seconds after the second phase for patients weighing less than 60 kg and 60 kg or more, respectively. The dataset was reconstructed with a 0.625-mm
section thickness and a 0.625-mm increment for Light Speed VCT Vision and with a 0.5-mm section thickness and a 0.5-mm increment for Aquilion 64, and then processed using 3-D multi-planer reconstruction (MPR) with a thin-slab maximum intensity projection (MIP) in the coronal plane with a 3-mm thickness and a 2-mm increment and volume rendering (VR) technique on a workstation (Ziostation, Zio Software, Tokyo, Japan).

<Contrast material>

To obtain dynamic contrast-enhanced CT images, a nonionic contrast agent (350 mgI/mL) was infused rapidly at 4.5 mL/sec using an automated injector (Dual Shot GX, Nemoto-Kyorindo, Tokyo, Japan) in a total volume of 100 mL followed by a 30-mL saline flush for patients weighing less than 60 kg. For patients weighing 60 kg or more, a nonionic contrast agent (300 mgI/mL) was infused at 5.0 mL/sec in a total volume of 150 mL followed by a 30-mL saline flush.

<Image analysis>

Two radiologists evaluated the trans-axial, 3-D MPR with MIP, VR images on the second phase images in combination with the first and third phase images, and classified the tributary of the MCV according to its drainage. Any discrepancies were resolved by consensus.

#Results#

Of 331 patients, the MCV drained into the SMV in 207 (62.5%) patients, the gastrocolic trunk (GCT) of Henle in 97 (29.3%) patients, the inferior mesenteric vein (IMV) in 16 (4.8%) patients, the splenic vein (SV) in 9 (2.7%) patients, and the jejunal vein (JV) in 2 (0.6%) patients.

#Discussion#

Few studies have been reported regarding the venous anatomy around SMV [2-8], especially the tributaries of the MCV. In the majority of previous studies, the anatomy of the MCV was examined by dissection of cadavers [3-5]. Jin et al [3] reported nine adult cadavers to define the venous tributaries of the SMV. In only one of the nine cases (11%), the superior right colic vein (SRCV), the right colic vein (RCV) and the MCV formed a confluence and drained into the GCT of Henle. In the other eight cases, the MCV drained into the SMV. Yamaguchi et al [4] reported that, among 58 cadavers, the MCV drained into the SMV in 49 (84.4%) cases, the GCT of Henle in 7 (12.0%), the SV in 2 (3.4%), and the IMV in one (1.7%).

To our knowledge, there have been only a few studies on the tributary of the MCV involving a large number of patients. Sakaguchi et al [6] reported that, among 102 patients
who underwent 3-D portography, the MCV could be identified in 96 patients. The MCV was composed of single and multiple trunks in 86 and 10 patients, respectively (double, \(n = 9\) and triple, \(n = 1\)). The 107 MCVs were classified into multiple types. The 21 MCVs formed the GCT of Henle with the right gastroepiploic vein. The 77 MCVs joined the SMV. The remaining 9 MCVs joined the SMV left trunk. In the group with a single trunk, the MCV drained into the GCT of Henle, the SMV or the left trunk in 62, 20 and 4 patients, respectively.

We performed 3-D CTA for all patients with gastric or colorectal cancers except for cases undergoing emergency surgeries. In the present study, we could identify the MCV in all the patients, and classified its tributary into five types. According to the previous reports, the most common type was the MCV draining into the SMV (Fig. 1). Our cases also had the same tendency followed by the type of draining into the GCT of Henle (Fig. 2 and 6). There were few cases with types of draining into the IMV or SV (Fig. 3 and 4). Furthermore there were only 2 cases with a type of draining into the JV (Fig. 5).

It is considered useful to identify the tributary of the MCV in such cases undergoing the following operation: lymph node dissection around the superior mesenteric artery and the SMV with transverse colectomy, right hemicolectomy, and distal pancreatectomy; dissection of the MCV with transverse colectomy; and dissection of the GCT of Henle with subtotal stomach-preserving pancreaticoduodenectomy. In cases with the MCV draining into the GCT of Henle, it could be possible to dissect the GCT of Henle in front of a tributary, and preserve the MCV.

In addition, it might be useful to identify the pathways of the tributaries of the MCV for the spread of the pancreatic and/or gastric diseases. The root of the transverse mesocolon locates at the antero-inferior surface of the pancreas body/tail on the left side, and crosses the middle level of the pancreas head on the right side. The transverse mesocolon is fused with various fascias. The vessels penetrating the concrescent layers join together at the root of the transverse mesocolon.

In cases with pancreatitis, for example, inflammation sometimes influences the root of the transverse mesocolon. Similarly, in cases of pancreatic cancer, it could help us know the range of the frontal invasion of the pancreas. In cases with gastric diseases, for example, greater curvature gastric ulcers occasionally course down the transverse mesocolon to create gastrocolic fistulas.

One of the limitations of this study is that all the patients were Japanese. There might be some difference among races in variance of the MCV. Another limitation is that we could not confirm tributaries of the MCV for all cases by surgery because this is a retrospective study.
**Fig. 1:** A 69-year-old man with gastric cancer before laparoscopy-assisted total gastrectomy. (A), (B) trans-axial and (C), (D) coronal multiplanar reconstruction (MPR) and maximum intensity projection (MIP) images clearly show the MCV is drained into the SMV. (E) CT angiographic reconstruction using volume rendering (VR) shows the MCV is drained into the superior mesenteric vein (SMV).

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Fig. 2: A 39-year-old woman with gastric cancer before laparoscopy-assisted distal gastrectomy. (A), (B) trans-axial and (C) coronal MPR and MIP images clearly show the MCV is drained into the GCT of Henle. (D) CT angiographic reconstruction using VR shows the MCV is drained into the GCT of Henle.

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Fig. 3: A 90-year-old man with gastric cancer for laparoscopy-assisted distal gastrectomy. (A), (B) trans-axial and (C) coronal MPR and MIP images clearly show the MCV is drained into the IMV. (D) CT angiographic reconstruction using VR shows the MCV is drained into the IMV.

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**Fig. 4:** A 59-year-old man with descending colon cancer before laparoscopic colectomy. (A), (B) trans-axial and (C) coronal MPR and MIP images clearly show the MCV is drained into the splenic vein (SV). (D) CT angiographic reconstruction using VR shows the MCV is drained into the SV.

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Fig. 5: A 78-year-old man with gastric cancer for laparoscopy-assisted distal gastrectomy. (A) trans-axial and (B) coronal MPR and MIP images clearly show the MCV is drained into the jejunal vein. (C) CT angiographic reconstruction using VR shows the MCV is drained into the JV.

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Fig. 6: Pie chart indicates the percentage of the tributary of the MCV. Of 331 patients, the MCV drained into the superior mesenteric vein in 207 (62.5%) patients, the gastrocolic trunk of Henle in 97 (29.3%) patients, the inferior mesenteric vein in 16 (4.8%) patients, the splenic vein in 9 (2.7%) patients, and the jejunal vein in 2 (0.6%) patients.

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Conclusion

It is important to be aware of the variations of the tributary of the MCV for preoperative planning and the extent of pancreatic and/or gastric diseases. 3-D CTA is useful to evaluate anatomic variants of the MCV.
References


