Paper VI

Vascular constraints in right colectomy for cancer

Clinical implications

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Abstract

BACKGROUND: The study aim was to provide data on pattern and length of crossing of ileocolic (ICA) and right colic artery (RCA) with superior mesenteric vein (SMV). METHODS: Specimens from 30 fresh human cadavers underwent corrosion casting. Methylacrylate was injected into the SMV and superior mesenteric artery. Length of crossing was measured with a scaleable ruler and copper wire. Values are mean ± standard error. RESULTS: ICA was present in all specimens crossing posterior to SMV in 19/30 specimens (63.33%). Length of crossing was 17.01±7.84 (7.09-42.89) mm. RCA was present in 19/30 specimens (63.33%). RCA crossed anterior to SMV in 16/19 specimens (84.21%). Length of crossing was 20.63±8.09 (6.3-35.7) mm. CONCLUSIONS: ICA was always present, crossed posterior to SMV in 60% of specimens with crossing length of 17 mm. RCA was present in 63% of specimens, crossed anterior to SMV in 84% of specimens with crossing length of 20 mm.

Key words:

Anatomy, right colectomy, blood supply

Introduction

A few studies on the vascular system of the right colon provide data on the mutual 3-dimentional (3-D) anatomical relations between the ileo-colic artery (ICA), the right colic artery (RCA), and the superior mesenteric vein (SMV) (1, 2). These studies reported that the ICA and RCA cross the SMV either anteriorly or posteriorly (1, 2). Even though this knowledge was available in the mid 70's (1), these 3-D relations are not widely known among surgeons performing right colectomy for cancer (RCC). Knowledge of this crossing pattern is of relevance to surgeons for a number of clinical implications. The lymph nodes of the right colon are located along the ICA and RCA (3, 4). R2 resections entail the division of the ICA and RCA at the right hand side of the SMV with the removal of the intermediate nodes. R3 resections entail the division of the ICA and RCA at the left hand side of the SMV with the additional removal of the main lymph nodes (5). Knowledge of the crossing pattern is of relevance not only to surgeons performing R3 resections. Arterial bleeding occurring after division of the ICA and/or RCA due to a loose clip, fallen ligature, or stapler misfire is another clinical implication of this knowledge for surgeons performing R2 resections. Whether the crossing pattern is anterior or posterior determines how these bleeding arterial stumps can be accessed without damaging the SMV. Such a task can be even more challenging to the laparoscopic surgeon (6).

The aim of this post-mortem study is to provide data on the pattern and length of the ICA and/or RCA crossing the SMV and discuss its clinical implications.

Materials and methods

Thirty consecutive fresh (<24 hour old) adult cadavers (14 men) aged 47-83 years were obtained from the Department of Pathology of Forde Central Hospital (22 cadavers), Norway and the Institute for Forensic Medicine, Belgrade, Serbia and Montenegro (8 cadavers). The pylorus, duodenum, pancreatic head with the portal vein and superior mesenteric artery (SMA), cecum, ascending colon, hepatic flexure, terminal ileum and corresponding mesentery were extracted en bloc through a midline incision. The cecum, ascending colon and hepatic flexure were mobilized and the hepato-duodenal ligament divided at its supraduodenal portion. The posterior surface of the pancreas was bluntly dissected together with the portal vein. The lesser sac was opened through the gastrocolic ligament. The transverse colon and mesocolon were divided on the left side of the middle colic artery. The stomach was transected over the pylorus and the pancreatic head divided from the body. The SMA was divided at its origin on the aorta. The jejunum was transected at the ligament of Treitz, and the small bowel mesentery divided from the corresponding bowel left of the mesenteric vessels. The terminal 15 cm of the ileum were included in the specimen. The specimen was removed and immediately after autopsy, immersed in 0.9% saline solution at 37° C.

Corrosion casting was carried out in all specimens. A 10 Fr polyethylene catheter was placed into the SMV and SMA, and irrigation with 0.9% saline solution was performed to wash out any retained clots. The branches of the SMV and SMA were identified and ligated to prevent leakage of cold-polymerizing methylacrylate during injection. The two polyethylene catheters were then fixed to each other with ligatures and methyl-acrylate in order to preserve their exact mutual relations prior to saponification.

Different colors were used to inject arteries and veins. Arteries were always injected first. During injection of cold polymerizing methyl acrylate through the catheters, the specimens were immersed in water in order to retain their original shape. Following methyl-acrylate solidification, corrosion by accelerated saponification was performed in a heated 35% potassium hydroxide solution. Any remnants of organic tissue were washed out with warm water and the casts mounted on stands.

The ICA was defined as the lowest right hand or terminal branch of the SMA. The RCA was defined as the first right hand branch arising from the SMA and crossing the SMV to the right colon. Branches from the ICA or middle colic arteries were not considered as RCA. The paths of the ICA and RCA were noted to cross either anterior or posterior to the SMV. The length of these arteries from their origin at the SMA to the right hand side of the SMV was measured. A nonius scaleable ruler and a flexible copper wire were used to measure vessel diameter and length, respectively.

The power analysis was based on the literature data available on the crossing pattern of the ICA and RCA, as anterior/posterior to the SMV: 52/48 (1), 33/67 (2); and 63/37 (2), 100/0 (7), respectively. The sample size was 30 cadavers with alpha 0.05 and study power 0.95. Values are mean ± standard error.

Results

The SMA was present in all specimens. Its diameter was 6.31 ± 1.07 (4.41-8.20) mm. The SMV was also present in all specimens and its diameter was 12.77 ± 2.57 (5.1-15.67) mm. The ICA was present in all specimens (Fig. 1). Its diameter was 3.24 ± 0.72 (1.99-4.73) mm. It crossed anterior to the SMV in 11 specimens (36.67%) and posterior in 19 (63.33%). The length of the ICA crossing was 17.01 ± 7.84 (7.09 - 42.89) mm.

The RCA arose from the SMA in 19 specimens (63.33%) (Fig. 2). The diameter of the RCA was 2.49 ± 0.59 (1.54-3.39) mm. The RCA passed anterior to the SMV in 16 specimens (84.21%) and posterior in 3 (15.79%). The length of the RCA crossing was 20.63 ± 8,10 (6.28-35.71) mm.

In one specimen there was a common stem for the RCA and middle colic artery. One specimen had double RCA and ICA. In two specimens, the injection of acrylate into the SMA resulted in the filling of the SMV with red colored acrylate through an arteriovenous fistula between the small branches of the SMA and SMV.

Discussion

The main finding of this postmortem study was the measurement of the length of the ICA and RCA crossing either anterior or posterior to the SMV. To the best of our knowledge there are no available data in the literature on these lengths. However, the data that is at hand is the length of the arteries (ICA: 67.4 mm; RCA: 45.2 mm) from their point of origin at the SMA to their first branching (8). It is not uncommon that operative reports of a RCC state that the ICA and RCA were ligated at their origin from the SMA, when in fact the ligation was done on the right hand side of the SMV removing the intermediate nodes where metastasis are reported to occur in 8-17 % (7, 10). When R2 resections are performed it is reasonable to assume that on average 25% of the length of the ICA (17 mm crossing length) and/or 50% of the RCA (21 mm crossing length) are left behind. Given this knowledge it is of relevance to keep in mind that the incidence of metastasis in main nodes is 3.2-5.8% (7, 10).

Another clinical implication is arterial bleeding that may occur in RCC. During ICA and/or RCA ligation, bleeding can be due to a fallen clip, loose suture, or stapler misfire. Assuming that the arteries are ligated at the right hand side of the SMV in a R2 resection, one can expect the bleeding arterial stump to retract behind the SMV. This is likely to be the case of a bleeding ICA stump, which has a posterior crossing pattern in 67% of the specimens. The RCA crosses posterior to the SMV in 14% of specimens, but in a more proximal position where the SMV has a larger diameter. Inadvertent injury to the SMV can be caused by attempts to control the bleeding. Whether the crossing pattern is anterior or posterior to the SMV determines how these bleeding arterial stumps can be accessed without damaging the SMV.

A third clinical implication would be in laparoscopic access. A bleeding arterial stump can be even more challenging to the laparoscopic surgeon since laparoscopy is burdened with the fulcrum effect, loss of 3-D vision and haptic feedback. This makes the laparoscopic surgeon especially susceptible to complications arising from inadequate knowledge of 3-D anatomy. Bleedings during ligation of the vascular pedicle in laparoscopic RCC occur between 3-9.2% cases (6), requiring conversion to open surgery in 1-2% cases (11).

Additional findings of this study are in accordance with the previous literature. The ICA was present in all cases and the relatively high presence of the RCA (63%) is within reported limits of 11-74% (1, 2, 8, 9). As far as the crossing pattern is concerned, our 67% rate is in accordance with the available data stating that the ICA crosses posterior to the SMV in 48-67% of the cases (1, 2). However, our 84% rate of anterior crossing of the RCA is much higher than the reported 63% rate (2).

The choice of performing an R2 or R3 resection has to be based on the likelihood that metastasis may be found in the main nodes. When a R3 resection is indicated it should be kept in mind that operating under the SMV could be hazardous, particularly laparoscopically. Knowledge of the crossing pattern of the ICA and RCA to the SMV is relevant to surgeons performing RCC.

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Fig 1.

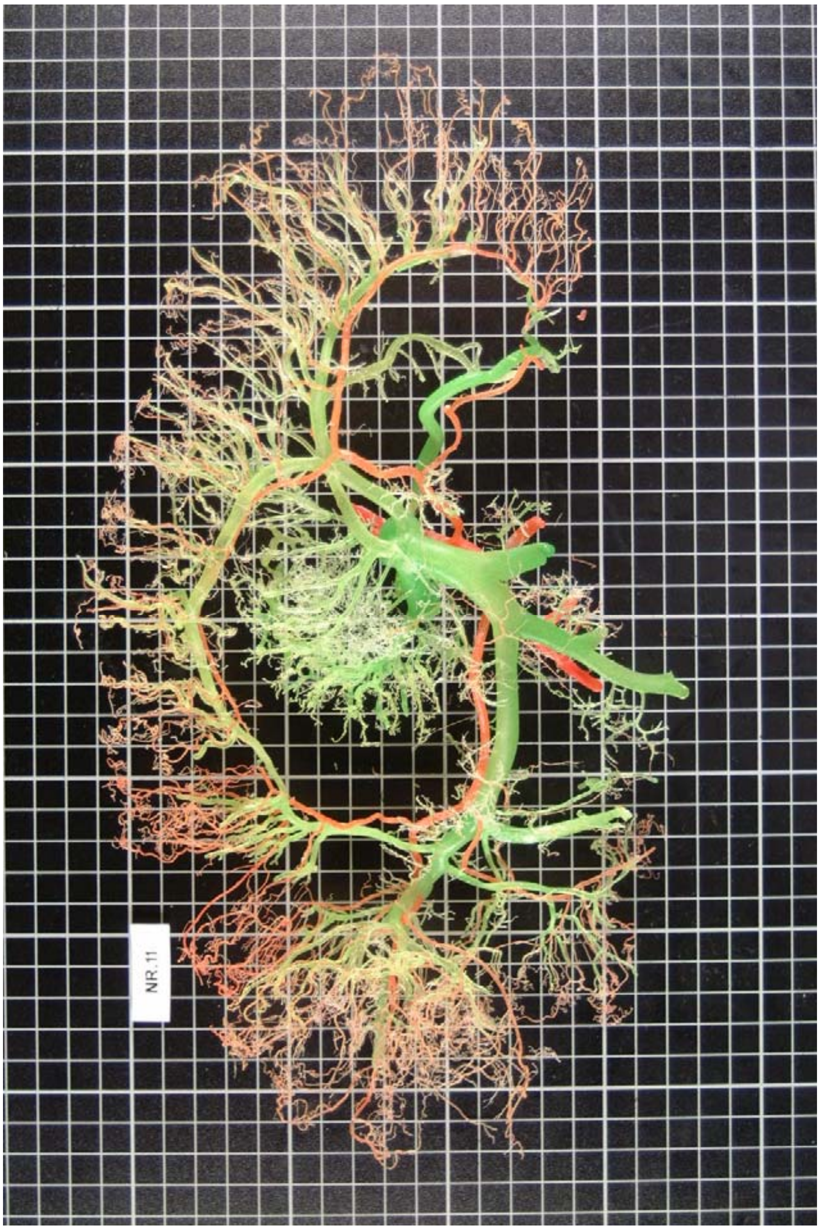

Fig 1. The ileo colic artery crosses the superior mesenteric vein posteriorly. The right colic artery is missing.

Fig 2.

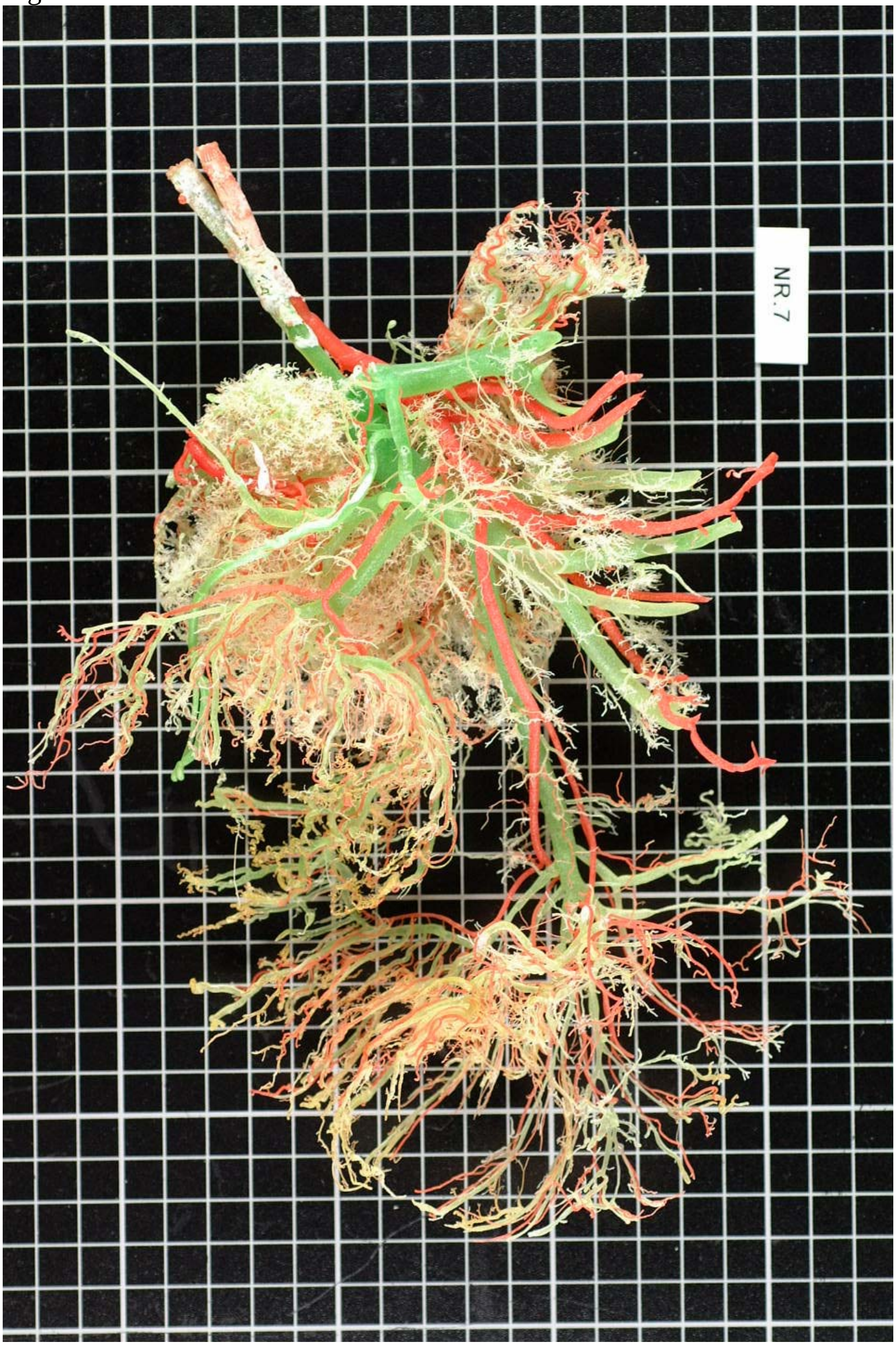

Fig. 2. Both the ileocolic artery and right colic artery cross anterior to the superior mesenteric vein.