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Original Article

Branching pattern of the colic branches of superior mesenteric artery-a cadaveric study

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ABSTRACT

PURPOSE: A thorough knowledge of the anatomy of colonic mesenteric arteries is necessary to accomplish successful uncomplicated abdominal operations, especially laparoscopic colonic resections in which the mesenteric vessels can't be palpated. Such knowledge is also important when performing a colonic resection for cancer using proximal vascular ligation and wide en bloc resection. Most surgical textbooks depict a "normal pattern" of arterial supply to the ascending and right 2/3 of transverse colon consists of three arterial branches the ileocolic artery(ICA), right colic artery(RCA) and the middle colic artery(MCA) arising independently from the superior mesenteric artery (SMA). Based on the literature, there are only two colonic arteries arising independently from the SMA in many cases. **METHOD:** In this study we mainly observed the branching pattern of colic branches of superior mesenteric arteries in 50 embalmed cadavers. **RESULTS:** In 90% cases the middle colic artery and in 66% the ileocolic artery arose directly from the SMA, the most variable artery was the RCA. In 46% cases, the RCA arose as a direct branch from SMA where as in 10% cases it formed a common stem with MCA and in 34% with ICA. The RCA was absent in 10% of cases. **CONCLUSION:** Knowledge of the colic vascular territories of the mesenteric arteries has a special interest in surgical practice because of the difficult post-operative revitalization of the colon. Therefore these findings will be of great help for surgeons and radiologists

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1. Introduction

With the advent of laparoscopy, colonic resections have become a common procedure leaving the mesenteric vessels impalpable. Thus inability to palpate vessels coupled with use of techniques that ligate these mesenteric vessels intra corporeally, it requires a thorough knowledge of mesenteric anatomy. The knowledge of anatomy of mesenteric arteries is also important during intestinal resections of cancer patients to prevent a hemorrhagic complication, which is one of the major cause for morbidity during laparoscopic intestinal surgery. Keeping in view the applied importance and to add up some more knowledge for already existing ones, the present study has been undertaken to study the branching pattern of the colic branches of superior mesenteric artery.

The SMA is the second ventral branch of abdominal aorta which itself is the largest artery in the abdominal cavity. The first anatomist who described the branches of SMA was Bartolomeo Eustachi[1]. The artery arises from the anterior surface of the abdominal aorta 1cm below the coeliac trunk(CT) at the level of lower border of L1 vertebra, from there it runs steeply downwards entering the upper end of mesentery of small intestine down along the roof of the mesentery to ileo-caecal junction. The SMA supplies the small intestine including duodenum inferior to the opening of bile duct, pancreas, caecum, appendix, ascending colon and right 2/3rd of the transverse colon.

The middle colic artery, right colic artery and ileocolic artery are the three colic branches of SMA. The MCA arises from right concave side of the SMA close to the origin of inferior pancreaticoduodenal artery (IPDA) later on it enters the root of the transverse mesocolon near the neck of the pancreas and descends between its layers and divides into right and a left branch. The right branch anastomoses with the ascending branch of right colic

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artery near the right colic flexure and left branch anastomoses with the ascending branch of left colic artery near the junction of right 2/3rd and left 1/3rd of transverse colon. The vascular arc so formed is called marginal artery of Drummond. It usually lies about 3-4cm away from the transverse colon within the transverse mesocolon[2].

The RCA which is the 2nd colic branch of SMA arises from the middle of the right concave surface of the SMA above the origin of ileocolic artery and runs to the right towards the ascending colon behind the peritoneum. During its course towards the ascending colon the artery crosses the right ureter, the right testicular or ovarian vessels and the right psoas major muscle. At or near the ascending colon the RCA further divides into ascending and descending branches which in turn anastomose with the branches of middle colic and ileocolic artery respectively[3].

The ICA, the third colic branch of SMA also arises from the concave right side of the SMA below the right colic artery and ascends retroperitoneally towards the right iliac fossa and ends by dividing into ascending and descending branches. On its course it crosses the gonadal vessels, ureter and psoas major muscle of right side. The ascending branch anastomoses with the descending branch of right colic artery to form the marginal artery whereas the descending branch gives anterior caecal, posterior caecal, appendicular and ileal branches[2].

2. Materials and methods

The study was conducted in M R Medical college, Gulbarga (2009-10) and included 50 embalmed cadavers(42 male and 8 female) which were kept for undergraduate dissection from the following medical colleges M. R. Medical College, Gulbarga, KBN Medical College, Gulbarga, BRIMS College, Bidar and BLDEA's Medical College, Bijapur, Karnataka. After the students dissected and studied the mesentery and the root of mesentery, the transverse colon was turned upwards to expose the infracolic part of mesentery. The small intestine was turned to the left side and the incision is made through the right layer of the peritoneum along the line of its attachment to the posterior abdominal wall, the fat from the mesentery is cleaned and the superior mesenteric artery and its branches were exposed. Further the colic branches of SMA were traced and their branching pattern was studied.

3. Results

In the present study all the three colic branches MCA, RCA and ICA arose from the SMA. In 90% of cases the MCA arose directly from the SMA where as in rest 10% cases it arose from a common trunk with RCA. The RCA, in 46% cases originated as a direct branch from SMA, it arose as a common stem in 10% cases with MCA and 34% cases with ICA. The RCA was absent in 10% of cases, in such cases the arterial supply of RCA was replaced by MCA. The ICA originated directly from SMA in 66% cases where as in 32% cases it arose from a common trunk along with RCA.

Table No 1: Origin of middle colic, right colic and ileocolic arteries are compared with previous authors.

| Author | year | No of specimen | MCA arising from SMA | RCA arising from SMA | ICA arising from SMA | RCA-MCA | RCA-ICA |
|-----------------|------|----------------|----------------------|----------------------|----------------------|---------|---------|
| Basmajian et al | 1955 | 45 | 64.4% | 26.7% | - | 42% | 35.6% |
| Michels et al | 1963 | 180 | 44% | 38% | - | 52% | 16% |
| Sonneland et al | 1958 | 600 | 67% | 28.3% | - | 29.7% | 38.8% |
| | 1933 | 40 | - | 40% | - | 30% | 12% |
| Thomas M | 1988 | 50 | 58% | 34% | - | 40% | 30% |
| Present study | 2011 | 50 | 90% | 46% | 63% | 10% | 34% |

MCA: Middle colic artery, RCA: Right colic artery, SMA: Superior mesenteric artery, ICA: Ileocolic artery, RCA-MCA: Right colic artery and middle colic artery arising from a common trunk, RCA-ICA: Right colic artery and ileocolic artery arising from a common trunk.

4. Discussion

Detailed knowledge of the colic branches of SMA is extremely important in this era of increasing number of laparoscopic surgery and interventional radiological procedures. The awareness of variant anatomy can result in more accurate interpretation of diseases and vascular involvement in diagnostic imaging, optimal selection of treatment options or operative planning, and help avoid iatrogenic injury from both surgical and interventional radiological procedures. So the study has been conducted to know the branching pattern of the colic branches of SMA.

The MCA, the first colic branch of SMA most commonly originates as an independent branch from SMA or sometimes it arises from a common stem along with the RCA[4].

The variations in the origin of MCA have been reported previously by many authors. Ronald M Bergman et al in his peer review reported a case of MCA arising from splenic artery/inferior mesenteric artery[4]. Yildirim M et al reported a variation in which the MCA was arising from CT[5, 6]. Garcia et al reported a case in which the MCA was arising from hepatic artery[1].

Thomas M Nelson et al observed two rare variations of MCA. He found that in 4% cases the MCA was branching off from ICA and in 16% cases he observed two middle colic arteries both had different origins[6]. E Ulucam et al reported a case in which middle colic artery took origin directly from abdominal aorta[7]. The dorsal pancreatic and inferior pancreaticoduodenal arteries sometimes arise from the MCA[4].

In the present study not much variations of MCA are seen. Here the MCA was present in all 50 cadavers, in 90% cases the MCA arose directly from SMA (Basmajian et al 64.4%, Michels et al 44%,Sonneland et al 67% and Thomas M Nelson et al 58%)[6], where as in rest 10% cases the MCA arose from a common trunk along with RCA and in 1 case the MCA was supplying till the splenic flexure.

The Right colic artery which is the second colic branch of SMA, in most cases it arises as an independent branch from the SMA. Occasionally it may arise with or as a branch of middle colic, ileocolic or the left colic artery. It is absent in 13% of individuals [4]. In the present study the RCA in 46% cases arose as a direct branch from SMA (Basmajian et al 26.7%, Michels et al 38%, Sonneland et al 28.3%, Steward and Rankin 40% and Thomas M Nelson et al 34%) where as in 10% cases it arose from a common stem with MCA (Basmajian et al 42%, Michels et al 52%, Sonneland et al 29.7%, Steward and Rankin 30% and Thomas M Nelson et al 40%) and in 34% cases from a common stem with ICA(Basmajian et al 35.6%, Michels et al 16%, Sonneland et al 38.8%, Steward and Rankin 12% and Thomas M Nelson et al 30%). The RCA was absent in 10% of cases.

The ileocolic artery, the third colic branch of SMA most commonly arises directly from the SMA or it can arise from a common stem with right colic artery. Thomas M Nelson et al reported a rare variation in which the RCA and MCA were arising from ICA and the ileocolic artery was the only artery supplying till splenic flexure[6]. In the present study in 66% of cases the ICA originated directly from the SMA where as in 34% cases the ICA formed a common trunk with RCA. The percentage of variations in the origin of MCA, RCA and ICA has been compared with various authors in table no 1.

5. Conclusion

This knowledge may be helpful in laparoscopic colon surgery, radical colon resections for cancer, and colon replacements after operations on the esophagus or the urinary bladder. The thorough mesenteric vascular knowledge also helps to ligate vessels approximately preventing major post-operative complications especially hemorrhage.

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