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Orginal Article

MORPHOLOGICAL VARIATIONS OF SUPERIOR MESENTERIC ARTERY: A CADAVERIC STUDY

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ABSTRACT

Background: Anatomical knowledge of the variations of Superior mesenteric artery (SMA) and its branches is important to minimize the complications and hence this article will be helpful for the clinicians planning surgery and intervention around the aforementioned vessels. **Materials and Methods**: In the present study, we studied the pattern of arrangement and distribution of the SMA in twenty cadavers in the gross anatomy dissection room in the department of anatomy, AIIMS, New Delhi. **Results and Discussion:** On the basis of branching pattern of SMA, the cadavers were divided into three groups I, II, III. Group I consisted of the most usual pattern of arrangement of SMA, in 70% of cases (14 cadavers). In Group II i.e. in 25 % cases (5 cadavers) we observed a common trunk of ileocolic and right colic arteries. Group III consisted of the rarest variation in the branching pattern of SMA, where we got a common trunk of left colic artery with an accessory splenic artery arising from anterior aspect of SMA, instead of Inferior mesenteric artery (IMA) which was seen in 5% cases (1 cadaver).Main splenic artery took origin from coeliac trunk as usual. **Conclusions:** These uncommon and rare variations in the branching pattern of arteries of the gut are clinically very important for surgeons and radiologists to prevent damage to these vessels which otherwise may lead to severe haemorrhage and other complications. In the present article we discuss about the morphology and development of the SMA along with its variations.

KEYWORDS: COLIC BRANCHES; ILEOCOLIC ARTERY; INFERIOR MESENTERIC ARTERY; SUPERIOR MESENTERIC ARTERY; VARIATIONS.

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INTRODUCTION

The superior mesenteric artery (SMA) is the artery of mid gut [1] which supplies the gut from the entrance of the bile duct into the duodenum to the junction of right two-third and left one-third of the transverse colon [2]. By convention, the boundaries of the foregut, midgut, and hind gut correspond to the territories of the arteries that supply the abdominal gut tube [3]. The gut tube and its derivatives are vascularised by unpaired ventral branches of the descending aorta. Three arteries serving the derivatives of Foregut, Midgut, and Hindgut respectively are Coeliac trunk (CT), Superior mesenteric artery (SMA), and Inferior mesenteric artery (IMA). Studies have shown that boundaries between the different endodermal segments along the cranial-caudal axis depends on patterns of segmental and homeotic gene expression within the gut that are established before the development of these vessels [3].

SMA originates from the aorta 1 cm below the coeliac trunk, at the level of the L1/2 intervertebral disc, posterior to the splenic vein and the body of the pancreas. It descends anterior to the left renal vein, the uncinate process of the pancreas, and the horizontal part of the duodenum, and runs in the root of the mesentery of the small intestine to the right iliac fossa. Here it ends by giving branches to ileum

and form an anastomosis with a branch of ileocolic artery in most of the cases [4]. The artery gives off several branches which include; the inferior pancreaticoduodenal artery from the posterior aspect, jejunal and ileal branches from the left surface and ileocolic, right colic and middle colic branches from right surface [5].

Numerous variations of the SMA regarding origin, course and branching pattern have been reported in the literature. Ceren Gunenc and C-Cem Denk reported unusual anatomical variation of the SMA and renal artery [6]. Oran, Yesildag, Memis et al reported a common splenomesenteric trunk branching into the splenic and SMA by angiographic study [7]. In about fifty percent (50%) of cases, the marginal artery which is a result of the anastomosis of the branches of the SMA and IMA may be discontinuous because of the failure of the anastomosis between the left and the right colic arteries [8]. The right colic artery may originate from the middle colic or ileocolic arteries, and a large branch, the Arc of Rioland, may occasionally connect the stem of the SMA with the left colic artery on the posterior abdominal wall [9,10, 11]. There have been reports of cases where the right and middle colic arteries were absent leaving the entire supply of the colon to the IMA. The most common variation of SMA is associated with the origin of a right hepatic artery which arises from the SMA [12,13] The knowledge of the anomalous arterial branching patterns is essential from the view point of surgical and radiological anatomy. So the present study was conducted to identify the variations in the branching pattern of superior mesenteric artery in light of its morphology and development.

MATERIALS AND METHODS

The present study was conducted on twenty cadavers with age ranging between 20 to 60 years (14 male and 06 female cadavers) in the Department of Anatomy, AIIMS, New Delhi. The dissection was conducted as per Cunningham's manual of practical anatomy. The peritoneum and the viscera's were carefully separated and cleaned from the field of view. Each of the SMA was then traced proximally and distally. Origin, course and branching pattern of SMAs were carefully observed. On the basis of branching pattern of the SMA the cadavers were grouped into three groups i.e., I, II, and III and prevalence of different variations in the branching pattern of SMA was calculated.

Group I: The most usual pattern of arrangement of SMA and was found in 70% of cases i.e. 14 cadavers (Table 1). Inferior pancreatico duodenal artery (IPD) arose from posterior surface of the SMA while 2-3 Jejunal branches and 5-15 ileal branches from the left side. Middle colic artery (MCA), Right colic artery (RCA), and Ileo-colic artery (ICA) originated from its right side (Fig 1). IPD artery passed upwards and to the right to form an arcade with the superior pancreatico duodenal (SPD) artery. Jejunal and ileal branches entered the mesentery. They branch and anatomosed to form arcades to supply the small intestine. The MCA ran forward in the transverse mesocolon to supply the transverse colon, divided into right and left branches which anastomosed with the ascending branch of RCA and ascending branch of left colic artery (LCA) respectively forming part of marginal artery [4].The ICA passed downwards, dividing into a superior branch which anastomoses with the descending branch of the RCA and an inferior branch that anastomosed with the end of the SMA. The RCA passed transversely across the structures of posterior abdominal wall to join the marginal artery, divided into ascending and descending branches.

Table 1: Different groups in the study with percentage of occurrence of variations in the branching pattern of SMA.

Group	Number of cadavers N= 20	Percentage (%)
I	14	70
II	5	25
III	1	5

[N: Total number of cadavers studied]

Group II: This group showed the presence of a common trunk of RCA and ICA arising from right side of SMA, which ran transversely and divided into an ascending and descending branches which anastomosed with the descending branch of MCA and terminal end of SMA respectively, forming marginal artery which then gave rise to branches to supply colon (Fig. 2).

Rest of the branching pattern was similar to the group I cadavers. Consisted of 25% of cases i.e., 5 cadavers (Table 1).

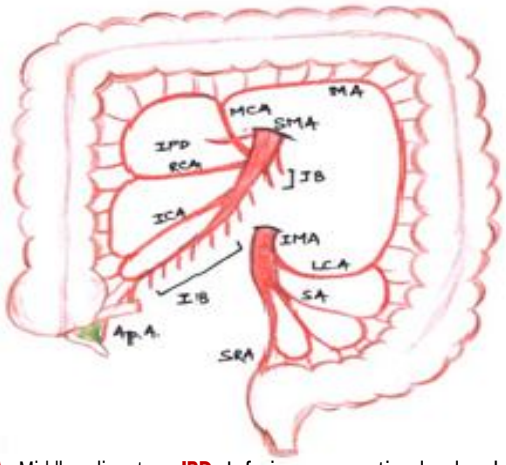
Group III: This group showed the rarest variation in the branching pattern of SMA. Here we got a common trunk of Left colic artery (LCA1) and Accessory splenic artery (ASA) arising from anterior aspect of SMA (Fig.4). LCA is normally a branch of IMA. In this cadaver we reported another small, tortuous artery (LCA2) arising from IMA, which is supposed to be a counter part of large LCA which here is arising from SMA.Both these arteries divided into ascending and descending branches and anastomosed with the adjacent arteries to form part of marginal artery (Fig 3, 4). ASP was running transversely behind the body of pancreas to reach the hilum of spleen. Main splenic artery took origin from celiac trunk as usual. Rest of the branching pattern was same as in group I. Constituted 5% of cases i.e., in one cadaver only (Table 1).

RESULTS AND DISCUSSION

In the present study we observed different variations in the branching pattern of SMA, on the basis of which the cadavers were divided into three groups. Group I showed the most usual pattern, consisted of 14 cadavers out of 20 (i.e., 70% cases).Group II showed the presence of a common trunk of RCA and ICA arising from right side of SMA, consisted of 5 cadavers out of 20 (i.e., 25% of cases). Group III showed the rarest variation in the branching pattern of SMA. There was a common trunk of Left colic artery (LCA1) and Accessory splenic artery (ASA) arising from anterior aspect of SMA, consisted of only 1 cadaver out of 20 (i.e., 5% cases).

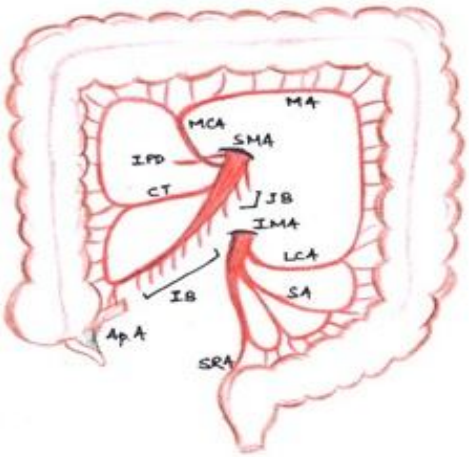
Variations of the visceral arteries are common, but there are some more exceptional anatomical variations that may puzzle the surgeons or vascular radiologists, dealing with intra-abdominal diseases [7] In the present study 70% of cases represented the most commonly documented branching pattern of SMA in roup I. This is in accordance with previous reports [2,14] .

Fig.1: Showing branching pattern of Superior mesenteric Artery (SMA) in Group I cadavers.



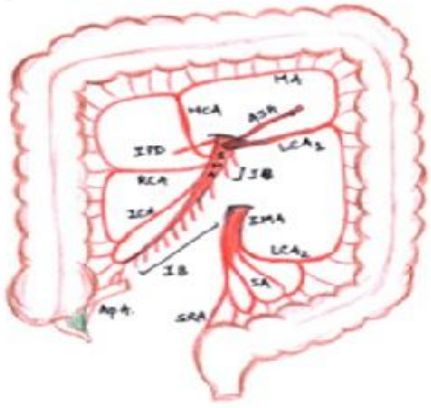
MCA: Middle colic artery; **IPD:** Inferior pancreaticoduodenal artery; **RCA:** Right colic artery; **ICA:** Ileo colic artery; **IMA:** Inferior mesenteric artery; **IB:** Ileal branches; **JB:** Jejunal branches; **MA:** Marginal artery; **SRA:** Superior rectal artery; **LCA:** Left colic artery; **SA:** Sigmoidal artery; **Ap.A:** Appendicular Artery.

Fig.2: Showing branching pattern of Superior Mesenteric Artery (SMA) in Group II cadavers.



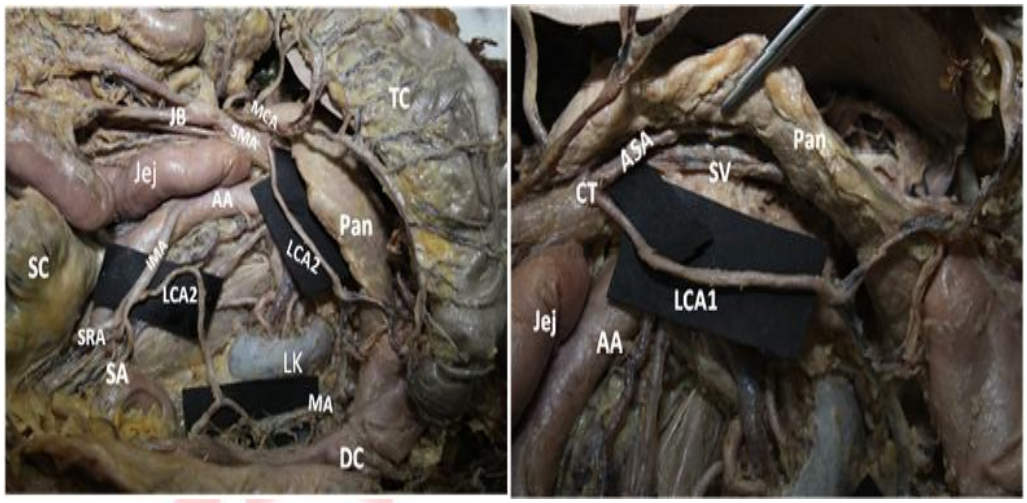
CT: Common trunk of IPD and RCA.

Fig.3: Showing branching pattern of Superior Mesenteric Artery (SMA) in Group III cadavers.



LCA1: Larger Left Colic artery; **ASA:**Accessory splenic artery; **LCA2:** Smaller left colic artery. **LCA2:** Smaller Left Colic artery.

Fig.4 (A & B): Showing branching pattern of Superior Mesenteric Artery in group III cadaver.



TC: Transverse colon; **SC:** Sigmoid colon; **Pan:** Pancreas; **LK:** Left kidney; **AA:**Abdominal Aorta; **DC:** Descending colon; **Jej:** Jejunum; **CT:** Common trunk of Accessory spenic artery **(ASA)** and Larger Left colic artery; **SV:** Spenic vein.

In group II, we observed common trunk of ICA and RCA in 25% cases. Igiri AO *et al* and observed RCA to originate from the ICA in 26.7% cases. Sonneland et al stated that 23.8% of 600 cases studied had their right colic artery arising from either the ileocolic artery or the middle colic artery [10].

Group III in our study represented with a rarest variation in the branching pattern of SMA. There was a common trunk which soon divided into a larger Left colic artery and a smaller splenic (accessory) artery. Thus SMA has supplied the whole of the transverse colon and upper part of descending colon, which are normally the territory of IMA. A common spleno- mesenteric trunk, which gives off the splenic and superior mesenteric artery has been reported with an incidence of less than 1% [7,13]. Dahiphale VP et al reported spenic artery to be arising from SMA [15].

Several other variations involving SMA have been reported like hepatic and cystic artery from the SMA [16, 17]. In rare cases the IMA has been reported to arise from the SMA either alone or along with the hepatic artery [18,19]. The right gastroepiploic artery has also been reported to arise from the SMA [20]. In other cases, branches' hitherto arising from the SMA has been reported to arise from the celiac trunk or from a coeliacomesenteric trunk [21].

Anatomical variations of these vessels are due to developmental changes in the ventral splanchnic arteries.

During development three groups of collateral arteries arise from the abdominal aorta as somatic intersegmental, lateral splanchnic and ventral splanchnic branches. The ventral splanchnic branches develop initially as a paired vessel, which then coalesce in the median line to form the four roots for the gut, the four roots being connected by the ventral longitudinal anastomoses. In the majority of cases the first three roots coalesce to form the celiac trunk and separate from the fourth root. The future superior mesenteric artery developed from the fourth root, which migrates caudally with the ventral migration of the gut. If the separation takes place at higher level, one of the celiac branches arises from the superior mesenteric artery [7]. This shows the developmental correlation of the variations in the branching pattern of SMA.

CONCLUSION

Knowledge of morphology and embryology of the visceral arteries is of immense significance. In depth knowledge of the anomalous branching pattern of SMA is essential for the successful accomplishment of the surgical, oncologic or interventional procedures including lymphadenectomy around a hepato-spleno-mesenteric trunk, aortic replacement with reimplantation of trunk and chemo-embolization of liver malignancies all of which can potentially create significant morbidity because of the large visceral territory supplied by a single vessel [22].

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