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Original article

Anatomy Section

Anatomical Variation and Clinical Implications of Celiac Trunk and Superior Mesenteric Arteries

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ABSTRACT

Introduction: Anatomical variations in the celiac, superior mesenteric and hepatic arterial branching patterns have a great clinical significance. The presence of certain variant patterns can be advantageous, while some can lead to life threatening complications. Many a times they are present throughout life and fortunately pass undetected. Yet their presence and incidence can be helpful for surgeons and radiologists to be aware of such variant patterns.

Objectives: To describe the peculiar variations found during routine cadaveric dissection which could be clinically significant.

Design: Dissections performed on 20 cadavers in a period of one year during undergraduate courses.

Main outcome: Variable anatomy of celiac and superior mesenteric arteries may be clinically significant in cases presenting with any disease related to the liver, gall bladder, pancreas, spleen, stomach or small intestine.

Results: In this study it was observed that 85% cadavers showed normal origin and course of hepatic arteries while 15 % cadavers showed variation. Out of the total one of them was having a hepatic artery arising from superior mesenteric artery, which can be beneficial for a liver graft, the other had a common celiac-mesenteric trunk which could be crucial in case of thromboembolic episode and the third and rarest had a trifurcation pattern of common hepatic artery.

Conclusion: Advances in diagnostic radiology can make such variant anatomy clear and help surgeons to take advantage of it in liver grafts or be aware of it before any surgical or radiological intervention.

Key Words: Arterial variations, Common celiac-superior mesenteric trunk, Trifurcation

INTRODUCTION

The gastrointestinal tract is supplied by three arteries –celiac, superior and inferior mesenteric. Several anatomical variations in their origin, course and distribution have been reported in the literature. Variations in the hepatic artery are common and advantageous in some clinical conditions. While some variations may create life threatening complications if not aware of prior to surgery. In view of recent advances in spiral and multidetector computed tomograph technique [MDCT], it is easy to obtain a thorough information about the variant anatomy beforehand [1,2]. The variations may range from celiac arterial anomalies, hepatic arterial patterns, common trunk of celiac and SMA, variation in branching pattern like bifurcation, trifurcation, quadrafurcation of the trunk and others [3]. Prior knowledge of the anomalous branching pattern of celiac and SMA is useful for successful surgical, laparoscopic and interventional radiological procedures on liver, gall bladder, pancreas, spleen, stomach and small intestine [1]. Keeping this in mind in this study we have explored the celiac trunk and SMA, traced their branching pattern and variation and discussed the embryological correlation and clinical significance.

MATERIALS AND METHODS

In the department of anatomy 20 cadavers, 10 male and 10 female bodies were dissected during routine undergraduate and post graduate courses in the year 2012-2013, and variations in the origin and course of hepatic arteries were observed. The origin and course of cystic artery and hepatic artery dividing into right and left branches were traced.

OBSERVATIONS AND RESULTS

Out of the 20 cadavers dissected 17 were having a normal course of hepatic artery arising from celiac trunk.

Variation 1- In one male cadaver aged 60 years the hepatic artery originating from celiac trunk supplied the left lobe of liver. A separate branch was seen going to the right lobe of the liver. When traced it was seen to be arising from the SMA, as its first branch. In its course it traversed through the right free border of the lesser omentum, behind the bile duct, gave the cystic artery and further coursed through the Calot's triangle to the right lobe of liver [Table/Fig-1].

Variation 2- In the second cadaver aged 65 years male, a common celio-mesenteric trunk [CCMT] was seen. The hepatic artery originated from CCMT and coursed upwards through the right border of the lesser omentum. Origin and course of the cystic artery was normal.Further the CCMT continued as SMA in the mesentry [Table/Fig-2].

Variation 3- In the third cadaver aged 62 years male, the origin of hepatic artery was normal. During its course it trifurcated into right hepatic artery, left hepatic artery and gastroduodenal artery 7.5 cms from origin and 5.5 cms from porta hepatis and just above the first part of duodenum. The cystic artery originated from right hepatic just distal to the trifurcation [Table/Fig-3].

RESULTS

In this study it was observed that 85% cadavers showed normal origin and course of hepatic arteries while 15% cadavers showed variation.

DISCUSSION

Normal anatomy of the arteries supplying the GIT

Celiac trunk normally arises from aorta at the level of 12th thoracic vertebra, after short course of 1.25 cms it divides into left gastric, common hepatic and splenic arteries. The common hepatic artery further gives a gastroduodenal artery at the upper border of first part of duodenum and courses as the hepatic artery proper in the right free margin of lesser omentum with the portal vein posteriorly and bile duct on its right side. It divides into right and left hepatic branches at or near the porta hepatis to supply respective physiological right and left lobes of the liver [4].

SMA arises from the abdominal aorta at the level of first lumbar vertebra. It runs anterior to first part of duodenum, enter the mesentry of small intestine. Its normal branches are inferior pancreaticoduodenal, jejunal ileal, ileocolic, right colic and middle colic arteries [4].

Embryological correlation of gut arteries

During development of the GIT many primitive ventral segmental arteries arise from the abdominal aorta to supply the developing GIT. Persistence of only three vessels ie 10th segmental, 13th and 21st or 22nd segmental arteries give rise to celiac, SMA and IMA arteries respectively. Their origins migrate caudally during further development of embryo [5].

According to Tandler's hypothesis [1,6,7] there is a longitudinal anastomosis between the primitive segmental arteries, which later regresses so that only the above mentioned three major vessels persist. Persistence, incomplete regression or disappearance of parts of these primitive ventral segmental arteries could give rise to variations of celiac and superior mesenteric arteries.

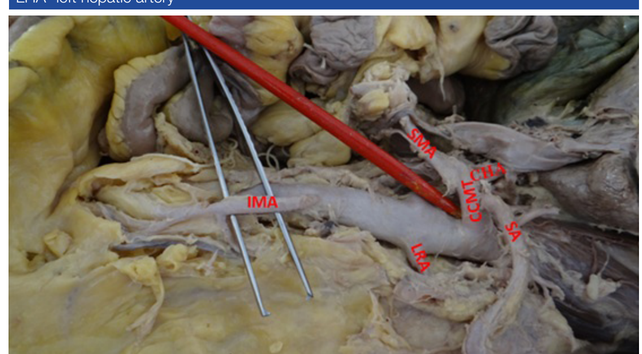
Clinical implications

Many variations in the pattern of origin and distribution of hepatic arteries are described.

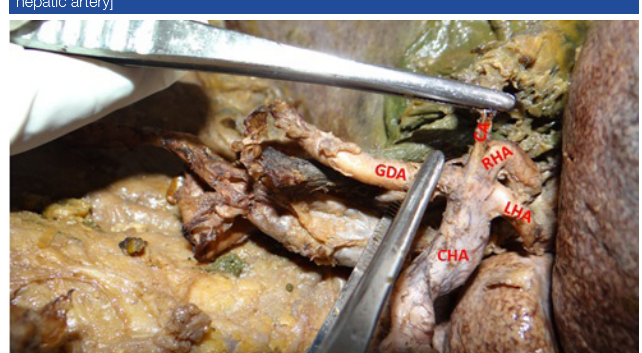
We discuss the clinical implications observed in our study.

Variations of common hepatic arteries are numerous and

[Table/Fig-1]: Shows variation 1: The common hepatic artery continues as LHA, RHA arising from SMA. CA arising from RHA.
SMA- Superior mesenteric artery, RHA –right hepatic artery, CA- cystic artery, CT-Celiac trunk, SA- Splenic artery,CHA- common hepatic artery, GDA- gastroduodenal artery, LHA- left hepatic artery



[Table/Fig-2]: Showing Variation 2: A common celiaco-mesenteric trunk. CCMT- common celiaco-mesenteric trunk, SMA- superior mesenteric artery, SA-splenic artery, IMA- inferior mesenteric artery, LRA- left renal artery, CHA- common hepatic artery]



[Table/Fig-3]: Showing Variation 3: Common hepatic artery showing trifurcation into RHA,LHA and GDA, Cystic artery arising from RHA. CHA- Common hepatic artery, RHA- right hepatic artery, LHA- left hepatic artery, CA- cystic artery, GDA- gastroduodenal artery account to about 8%. Replaced right hepatic RHA as seen in our variation 1 is defined as the artery supplying the right lobe in place of typical celiac hepatic anatomy [8]. This replaced RHA may be due to the persistence of longitudinal ventral arterial segment connected to SMA. Detection of such a replaced RHA by surgeons and radiologists is crucial prior to any abdominal surgery, as it may lead to inadvertent ligation followed by right lobe ischemia or infarct. This variation of replaced RHA from SMA has the highest incidence, 8.5 % [1] and can be more easily isolated. This fact can provide a large graft and be esy to anastomose under loupe magnification during liver transplants [8]. Knowledge of this variant artery can thus be utilized in branch patch reconstruction in transplant donors with replced type arterial variation. There was no vascular complication of both donor and recipient [8,9]. Moreover in this case care should be rendered while operating on the gall bladder as the replaced RHA was in the Calot's triangle and may be inadvertently ligated during surgeries.

The other variation i.e a common celiac –mesenteric trunk is rare < 1% of all abdominal vascular anomalies [0.25% incidence]. It can be explained by the regression of the tenth root and persistence of both 13th root and anterior longitudinal anastomosis [6,10].

SMA embolism is a common clinical problem. Approximately 4 % of all arterial emboli lodge in the SMA [8]. The causes may be varied eg: arterial fibrillation, mitral stenosis, myocardial infarction, atheromatosis, aneurysm and others [12]. The presence of a common trunk in such cases may not allow collateral circulation and jeopardise many organs including liver, pancreas, stomach and small intestine – derivatives of both foregut and midgut. Also in such patients while giving thrombolytic therapy care should be taken and meticulous evaluation done. Early treatment in such cases can avoid extensive damage, morbidity and /or mortality [13].

The common trunk can also be occluded by median arcuate ligament [MAL] leading to Dunbar syndrome [7,14]. If it is compression of celiac trunk alone as in normal anatomy, it would not present with early symptoms due to the rich collaterals between celiac and SMA. But if the compression is in such a variant anatomy it may hamper blood supply of both foregut as well as midgut derivatives.

The third variation is most peculiar and the rarest of all [2]. The branching pattern of the arteries supplying the gut is described by various authors, Prakash et al., [15], Soong et al., [16], Michels et al., [17], and it ranged from bifurcation patterns to exafurcation patterns [3]. According to Michel's classification Types 1 to 6 are described based on normal and variant branching patterns. Our variation 2, fits into the type 6 pattern. According to Lipshutz [18] four types were described based on origin of artery and its mode of distribution. Our third case is peculiar as it shows trifurcation into right and left hepatic and gastroduodenal arteries within the lesser omentum and does not fit into the types given by Michel and Lipshutz and hence rarest as mentioned by Satheesha Nayak et al. This varied branching pattern can make hepatic arterial infusion chemotherapy and microcatheter embolization techniques difficult [19].

CONCLUSION

The variant anatomy of arteries supplying the gut can be utilized during some surgeries while they can also create life threatening complications in certain situations. A CT angiography or a MDCT can be valuable in understanding such variations. As such variant anatomy is quite common prior knowledge of it is of real help to radiologists and surgeons before planning for any intervention. Hence screening for variant anatomy should be included in the routine pre-operative investigations protocol before any major abdominal surgeries.

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