VARIATIONS IN THE ARTERIAL BRANCHING PATTERN OF THE COELIAC TRUNK: A CADAVERIC STUDYArindom Banerjee¹**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: The knowledge of the anomalous arterial branching patterns is essential from the view point of surgical anatomy, especially while contemplating hepatic and pancreatic surgeries. The anatomical variations of the celiac trunk, superior mesenteric artery, renal and gonadal arteries are well established. The presence of anomalous origin of the inferior phrenic artery from the celiac trunk is comparatively rare in available literature but is clinically very important because this may act as a major source of collateral or parasitized arterial supply to hepato-cellular carcinoma, second only to the hepatic artery. The present study was carried out from the data collected over a period of four years when routine dissection was done while teaching the first year MBBS undergraduate students. The arterial branching pattern of the coeliaco-mesenteric axis was noted down from a total of 40 cadavers (10 each year) and any anomalous pattern observed was documented. In our study we observed a lower origin of the celiac trunk through the substance of the pancreas in 3 cases, presence of two separate trunks namely gastro-splenic and hepato-mesenteric arising from the abdominal aorta in 4 cases and both inferior phrenic arteries arising from celiac trunk in 1 case. The remaining 32 cadavers had normal arterial branching pattern. These anomalies could cause a catastrophe during surgical procedures, especially laparoscopic ones if the same is not kept in mind before contemplating pre-operative investigations. The awareness of these vascular anomalies is very important while contemplating radiological and surgical interventions. Therefore keeping in mind the immense radiological and surgical importance of these variations, the continuous reporting of such cases is significant.

KEYWORDS: (Celiac Trunk), (Superior Mesenteric Artery), (Anomalous Branching Pattern), (Surgical Interventions).

INTRODUCTION: The knowledge of the anomalous arterial branching patterns is essential from the view point of surgical anatomy, especially while contemplating hepatic and pancreatic surgeries. The coeliac trunk, the chief arterial supply for the foregut derivatives and one of the ventral branches of the abdominal aorta, usually gives origin to three branches, namely the splenic artery, the common hepatic artery and the left gastric artery. In antithesis, the superior mesenteric artery, yet another ventral branch of the abdominal aorta, supplies the midgut derivatives. Adachi^[1], depending upon the patterns of ramification of the coeliac trunk, classified them into six types. According to Adachi's classification, when the hepatic artery and the superior mesenteric artery arise from a common stump which is named as the hepato-mesenteric artery and pass anterior to the portal vein, it is referred to the type V anomaly. In his study on 252 Japanese specimens, this anomaly was reported only in 0.4% of the cases. The celiac trunk (CT) is the major visceral branch of the abdominal aorta originating at its anterior contour just below the aortic hiatus of diaphragm at the level of T12- L1 vertebral bodies. It is about 1.5-2cm long and 6-8 mm in diameter.

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It passes almost horizontally forward and divides into 3 branches – left gastric, splenic and common hepatic arteries.^[2] The most common form of the CT is tripodal. According to Michels, this tripodal form occurs in 55% of individuals.^[3] Van Damme and Bonte reported that this form occurs in 86% of individuals.^[4] The trifurcation of CT was first described by Haller in 1756. This “Tripus Halleri” is still considered to be the normal appearance of the CT,^[5] although many variations in patterns of the CT have been described. It appears that only 87.6% of the CT exhibited the classical trifurcation, while an incomplete CT accounted for 12.2% and absence of the CT was extremely rare.^[6] Anatomical variations in the branching pattern of the CT are of considerable importance in liver transplants, laparoscopic surgery, radiological abdominal interventions and penetrating injuries to the abdomen.

Knowledge of these variations is important for proper preoperative diagnosis and planning of surgical and radiological procedures. Regarding inferior phrenic arteries, which irrigate the diaphragm, it is known that they vary in relation to their origin. Vascular variations are constantly observed in dissection of adult cadavers.^[7] Recent advances stress upon the fact that right inferior phrenic artery is the most common extrahepatic feeding artery supplying the hepatocellular carcinoma. The great importance of such knowledge lies in the fact that an unresectable hepatocellular carcinoma can be treated by transcatheter embolization of not only its typical blood supply, the right or left hepatic arteries, but also by embolization of a right inferior phrenic artery, if involved.^[8] These arteries also contribute to arterial supply of adrenal glands are of thus importance in angiographic examination for adrenal lesions.^[9] According to Pick and Anson,^[10] these arteries may arise from the coeliac artery (34.8%), aorta (26.3%) or from a common trunk that stems from the aorta (18.5%) or coeliac trunk (13.0%). Rarely, it may arise from the renal artery (5.8%).

METHODS: The present study was carried out from data collected through cadaveric dissection during routine teaching for first year MBBS undergraduate students at the Department of Anatomy, Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram over a period of 4 years. 40 cadavers were carefully dissected (10 per year) and the branching pattern of the celiac artery and superior mesenteric artery were observed. Any anomalous pattern was studied and documented with photograph.

RESULTS: In the 40 cadavers which were dissected, 32 showed normal anatomy of the coeliac and superior mesenteric artery whereas the remaining 8 cadavers showed variations which were observed and documented as mentioned below:

Observation 1: The celiac trunk has lower origin from the abdominal aorta through the substance of the pancreas – 3 cases (Figure 1).

Observation 2: Presence of two separate trunks namely gastro-splenic and hepato-mesenteric arising from the abdominal aorta -4 cases (Figure 2).

Observation 3: The right and left inferior phrenic artery arises from the trunk of celiac artery instead of arising as lateral branches of the abdominal aorta -1 case (Figure 3).

DISCUSSION: The discussion of this study can be done based on the observations made of the various arterial anomalies.

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Observation 1: The celiac trunk has lower origin from the abdominal aorta through the substance of the pancreas – 3 cases.

In this case the coeliac trunk was present at the level of L1 vertebrae in all the three cases and a portion of the head of the pancreas had to be dissected out to clearly see the origin from the abdominal aorta. Similar observations were made other authors with varying frequencies at different levels.^[11] Garima Sehgal et al.^[12] reported origin of coeliac trunk at various levels ranging from T11 –L1. A high origin of coeliac artery may give rise to coeliac axis compression syndrome leading to severe post-prandial epigastric pain, nausea and vomiting. In our study we did not find any case of high origin of the coeliac trunk. Variability of the level of origin of coeliac trunk is importance for planning for surgical treatment of carcinoma of stomach and pancreas and special interest should be paid to the visualization of the hepato-biliary tree because lymph nodes associated with it may be compressed by the high coeliac trunk.

Observation 2: Presence of two separate trunks namely gastro-splenic and hepato-mesenteric arising from the abdominal aorta -4 cases.

This was the commonest type of anomaly observed. Our case fitted well into Morita's hypothesis.^[13] Disappearance of the proximal part of the 2nd and 3rd roots and the longitudinal anastomosis between them led to the formation of the gastro-splenic trunk and its branches (Formed by the entire 1st root, the distal part of the 2nd root and the anastomosis between them) and the hepato-mesenteric trunk and its branches (Formed by the entire 4th root, the distal part of the 3rd root and the anastomosis between them). Subsequently, the distal part of the 1st root formed the left gastric artery, the distal part of the 2nd root formed the splenic artery, the distal part of the 3rd root formed the common hepatic artery and the distal part of the 4th root formed the superior mesenteric artery. The proximal part of the 1st root and the 4th root formed the gastro-splenic trunk and the hepato-mesenteric trunk respectively.

Observation 3: The right and left inferior phrenic artery arises from the trunk of celiac artery instead of arising as lateral branches of the abdominal aorta -1 case.

Considering the paucity of information presently available concerning these arteries, Gray's Anatomy.^[14] gives the most complete textbook account, claiming origins from both the celiac trunk and aorta, as well as describing common trunk origins and mentioning alternative origins, including the renal or accessory renal arteries, the left gastric, hepatic, and gonadal arteries. According to Nayak SR.^[15] the left inferior phrenic artery was seen to take origin from the celiac artery as its first branch. In another study done by Pulakunta T.^[16] the inferior phrenic artery showed a variant origin in four out of 32 cases. It was seen to arise directly from the celiac trunk in two cases and there was one case arising from the left gastric artery and another from the right renal artery.

The computed tomography (CT) study by Gokan et al.^[17] described these arteries with slightly greater detail and included actual percentages. They found that the most frequent origins were from the aorta and celiac trunk, with 46% of specimens presenting an aortic origin, most commonly on the right side, and a celiac origin, most commonly on the left (52%). They also observed the RIPA arising from the right renal artery in 9% of cases studied. With the advances in the surgical techniques, increased concern for the post-operative cosmetic appearance and the advent of still newer horizons of treatment like laparoscopic operations, surgeons may not have the opportunity of seeing the entire surgical operative area, which necessitates well planned pre-operative investigations and an

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appropriate knowledge of the possible anomalies of that particular region. This will avoid or at least reduce the risk of inadvertently damaging the blood vessels, thereby preventing the conversion of a lifesaving operation to a life threatening one. Modern surgical techniques depend in part on knowledge of both the normal and the anomalous arterial blood supply. The inferior phrenic artery is a major source of collateral or parasitized blood supply to hepatocellular carcinoma, second only to hepatic artery. This is useful to evaluate the efficacy and safety of transcatheter oily chemoembolization therapy (TOCE) via the inferior phrenic artery (IPA) in hepatocellular carcinoma (HCC). Therefore keeping the above mentioned facts in view the continuous reporting of the anomalous branching patterns of the coeliac trunk and also the superior mesenteric artery becomes very important.

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Figure 1: Shows the lower origin of the coeliac trunk from the abdominal aorta. A portion of the head of the pancreas had to be dissected out to see the origin of the coeliac trunk.

Fig. 1

Figure 2: Showing gastro-splenic trunk & hepato- mesenteric trunk arising from ventral aspect of abdominal aorta.

A A = Abdominal Aorta; GST = Gastro- Splenic Trunk; LGA = Left Gastric Artery;
SA = Splenic Artery; HMT = Hepato- Mesenteric trunk; CHA = Common Hepatic Artery;
SMA = Superior Mesenteric Artery; GDA = Gastro-duodenal artery; HAP = Hepatic Artery Proper.

Fig. 2

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Figure 3: Showing the origins of the right and the left inferior phrenic arteries from the coeliac trunk. RIPA = right inferior phrenic artery/ LIPA = left inferior phrenic artery. LGA = left gastric artery/ SA = splenic artery/ CHA = common hepatic artery.

Fig. 3

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