CASE REPORT

# Variation of visceral arterial anatomy in the background of thoraco abdominal aortic aneurysm

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## Introduction

The branches of the abdominal aorta (AA) consist of paired visceral branches, unpaired visceral branches and parietal branches. Paired visceral branches include suprarenal, renal and gonadal arteries. Unpaired visceral branches include the coeliac trunk (CT), the superior mesenteric artery (SMA) and the inferior mesenteric artery (IMA). Parietal branches include the inferior phrenic arteries and the lumbar arteries. The development of the abdominal aorta starts in the third week of embryological development by the migration of cells from the endocardial mesenchyme, forming two dorsal aortas, which later fuse to form the abdominal aorta. Some of the primitive segmental branches regress over time, and others branch or make connections with other segmental branches to give origin to a final, definite set of branches. Aberrations of this mechanism can give rise to aberrant branches, accessory branches and abnormal divisions. This causes high prevalence of variations of visceral branches of the aorta in terms of level of origin, branching patterns, trunk formation and course. These variations, especially in the visceral branches, are significant clinically, requiring awareness among surgeons, radiologists, and interventionalists to avoid complications inprocedures like transplantation, angioembolization, and aneurysm repair. We discuss a case of a patient who presented with a thoraco-abdominal aortic aneurysm (TAAA) with multiple variations of visceral anatomical branches. The case is reported due to the rarity of such presentations and the implications of such variations on aortic surgeries.

## Case presentation

A 66-year-old male presented to the National Hospital of Sri Lanka, with a history of chronic back pain for two years, with intermittent abdominal pain. He was a patient with hypertension, dyslipidaemia and ischaemic heart disease. He also was treated for syphilis in the past. Since his initial investigations were unremarkable, it was decided to proceed with contrast CT aortogram . This revealed two aneurysms of the aorta, including the descending thoracic aorta (DTAA) and infrarenal AA. DTAA extended from the seventh thoracic (T7) to the twelfth thoracic (T12) vertebral level, and the abdominal aneurysm was at the third lumbar (L3) to the fourth lumbar (L4) vertebral level. Except for the IMA, all other visceral branches of the aorta originated from the unaffected segment of the aorta. However, a significant number of variations were noted among the visceral branches (Figure 1).

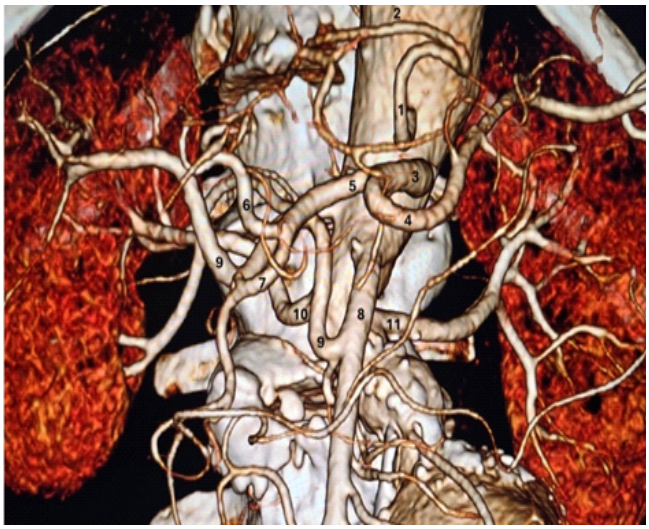

**Figure 1:** CECT 3D Reconstruction View of Aorta

1 - Abnormal Left Gastric Artery, 2 - Accessory Left Hepatic Artery, 3 - Hepatic Splenic Trunk, 4 - Splenic Artery, 5 - Common Hepatic Artery, 6 - Left Hepatic Artery, 7 - Gastroduodenal Artery, 8 - Hepatic Mesenteric Trunk, 9- Right Hepatic Artery, 10 - Right Renal Artery, 11 - Left Renal Artery

The left gastric artery (LGA) had a direct origin from the aorta, giving rise to an accessory left hepatic artery (ALHA). Below the level of origin of LGA, the splenic artery (SA) and the common hepatic artery (CHA) originated as a common trunk (HST). CHA gave origin to the left hepatic artery (LHA) and gastroduodenal artery (GDA). SMA, which originated below the level of the HST, gave rise to the replaced right hepatic artery (RHA). Renal arteries demonstrated the normal

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anatomy. The vertebral levels of origin of all the visceral arteries were normal. The ALHA arose 6.4mm above the origin of the HST.

**Discussion**

The great variability in the vasculature of the abdominal organs makes the preoperative evaluation of the arterial anatomy extremely important. Among all the visceral branches, renal arteries have the highest incidence of variations, which can be as high as 40% of the population. Accessory unilateral renal arteries are seen in 30% of the population, while 10% can have bilateral accessory renal arteries [1].

The embryological origins of these vessels can explain the occurrence of these anatomical variations. During foetal development, both the CT and the SMA develop as serial ventral branches of the dorsal aorta. These serial branches are called the omphalo-mesenteric arteries (OMA) [2] (Figure 2).

A ventral longitudinal vessel joins the OMA. During further foetal development, the Superior OMA develops into the CT. The longitudinal anastomosis gives rise to the LGA, splenic artery (SA), and the middle hepatic arteries (MHA). Furthermore, in the development, the left hepatic artery (LHA) arises from the LGA, while the right hepatic artery originates from the SMA. The hepatic arteries originating from the LGA and SMA degenerate, and the MHA develops into the CHA and proper hepatic artery (PHA). PHA divides into RHA and LHA.

In the above-mentioned case, the indicated variations occurred due to the failure of the development of the RHA from the MHA and the persistence of the embryological pattern of other hepatic arteries, namely the LHA emerging from the LGA and the RHA from the SMA. Furthermore, the above-mentioned variation in the LGA originating directly from the aorta, probably developed by the embryological LGA migrating onto the aorta.

Although 83% of the population has a coeliac trunk with a trifurcation, 10% can have a bifurcated coeliac trunk, while 6% can have a quadrifurcated colic trunk, where the middle colic artery and RHA can directly arise from the CT as the fourth branch. Rarely, in 1% of the population, all the branches of the coeliac trunk can have direct origins from the aorta, leaving no proper coeliac trunk [3]. Cadaveric and image-based studies have reported 23% of SMA branching variations. Few cases are reported regarding the direct origin of the left gastric artery from the aorta, as well as the presence of HST. The prevalence of HST is about 1.5% [1]. The reported prevalence of hepato-mesenteric trunk is 1.0-4.5% [4]. The two most widely accepted classifications of hepatic arterial variations are those by Michels, based on 200 autopsies, and Hiatt, based on 1000 angiographic analyses [5].

In summary, this is a patient with Michels type 3 right hepatic artery (Replaced RHA by SMA), Michels type 5 left hepatic artery (Accessory LHA) and a hepato-splenic trunk.

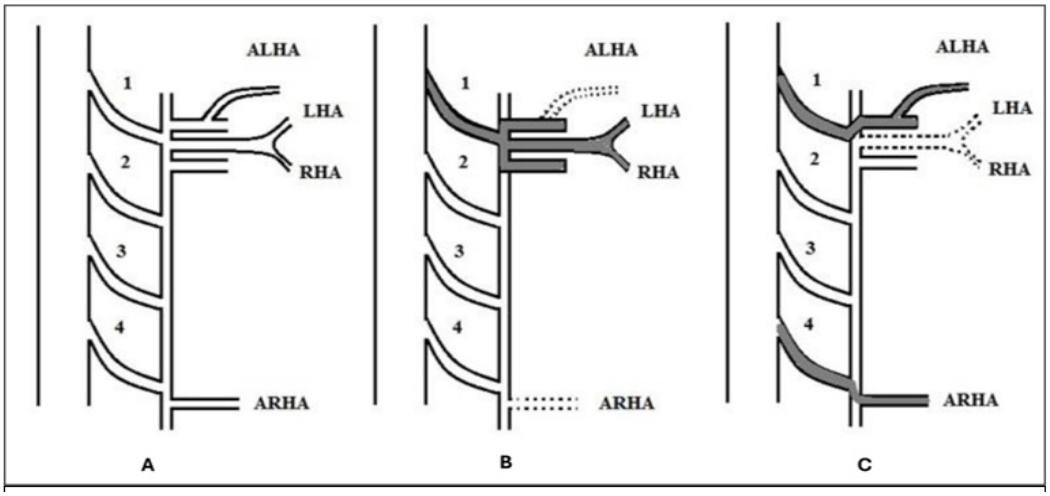


**Figure 2:** Embryological Basis of development of described anatomical variations

A - Multiple Omphalo Mesenteric Arteries Arising from Primitive Aorta

B - Regression of Primitive Vessels and Development of Coeliac Trunk in a Normal Person

C - Regression of Common Hepatic Artery and Persistent Accessory Left Hepatic Artery

In the above-described case, during the open DTAA repair, the lower end of the graft will be sutured at the level of the HST. This means that the abnormal ALGA should be reimplanted. If the variations were not known before surgery, the ALGA would be damaged, resulting in ischemia to the left lobe of the liver. Therefore, this case demonstrates the importance of knowing the anatomical variations before planning the vascular surgeries.

**Conclusion**

The aorta can have multiple combinations of variations of its visceral branches. Therefore, preoperative assessment of these variations in planning open and endovascular aortic procedures is of paramount importance in minimising complications and improving patient outcomes.

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**Learning Points:**

- Visceral branches of aorta may show wide variety of variations.
- Pre operative assessment of the arterial branching anatomy is important in improving outcomes related to procedures of aorta.