

## VARIATIONS IN THE BRANCHING PATTERN OF COELIAC ARTERY IN ADULT HUMAN CADAVERS OF TAMILNADU WITH CLINICAL AND EMBRYOLOGICAL RELEVANCE

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### ABSTRACT

**Background and objectives:** Variations in the branching pattern of coeliac artery not only interest the anatomist but a thorough knowledge of their normal and variant anatomy is very essential for surgeons and radiologists because of their impact in visceral surgery and medico legal implications. The aim of this study is to observe and analyse the variations in the branching pattern of coeliac artery.

**Materials and methods:** The study material comprised of fifty embalmed adult human cadavers obtained from Institute Of Anatomy, Madras Medical College. Dissection was done as per Cunningham's manual.

**Results:** Among fifty specimens, 4% specimens depicted a rare variation where the coeliac artery quadrifurcated into left gastric artery, splenic artery, common hepatic artery and dorsal pancreatic artery. In 78% specimens coeliac artery gave origin to its three classic branches and in 18% specimens the coeliac artery gave origin to inferior phrenic arteries in addition to its classic branches.

**Conclusion:** Knowing the vascular anatomy, their incidence and variations help surgeons to plan and individualize the treatment strategy accordingly. This remarkably improves the safety and success of the surgery and lowers postoperative morbidity.

**KEYWORDS:** Coeliac artery, Dorsal pancreatic artery, Inferior phrenic artery.

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### INTRODUCTION

Coeliac artery is the artery supplying the infradiaphragmatic part of the foregut namely the abdominal part of oesophagus, stomach, duodenum, liver, pancreas, spleen. It is the first ventral branch of abdominal aorta just below the aortic opening of the diaphragm. It divides into its three classic branches- left gastric, common hepatic, splenic. In some instances one of these branches arise separately from abdominal aorta

or the coeliac artery can be entirely absent with all its three classic branches arising directly from abdominal aorta. In addition to these branches other aberrant branches like inferior phrenic, dorsal pancreatic, gastroduodenal arteries can also arise from coeliac artery [1].

In rare cases the coeliac artery and superior mesenteric artery can originate as a common trunk called coeliacomesenteric trunk from abdominal aorta [2].

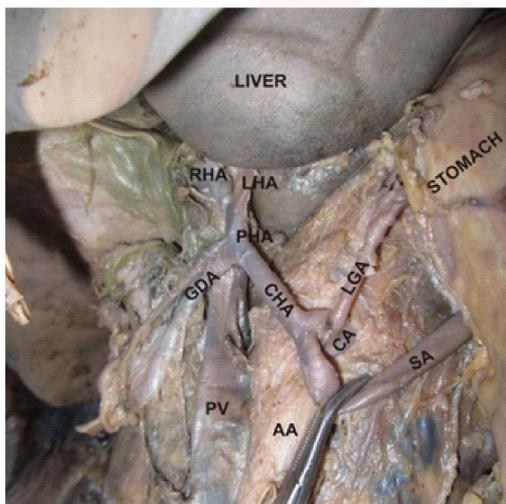
## MATERIALS AND METHODS

The material for this study comprised of 50 embalmed adult human cadavers allotted for routine academic dissection to the first year MBBS and BDS students at the Institute Of Anatomy, Madras Medical College, Chennai, Tamilnadu, India.

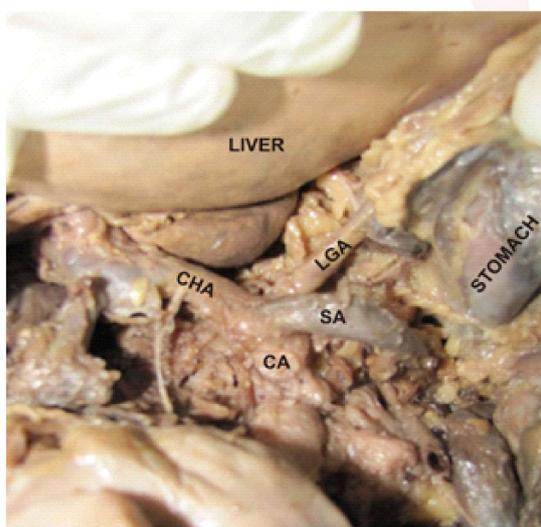
The dissection of the anterior abdominal wall and peritoneum was done as per Cunningham's manual. The coeliac artery was identified and dense autonomic plexus surrounding it was removed to expose its branches[3]. All the branches of coeliac artery were carefully traced. Photographs were taken and recorded. The details about the branching pattern of coeliac artery in every specimen were recorded and analysed. Institutional ethical committee clearance received.

## RESULTS

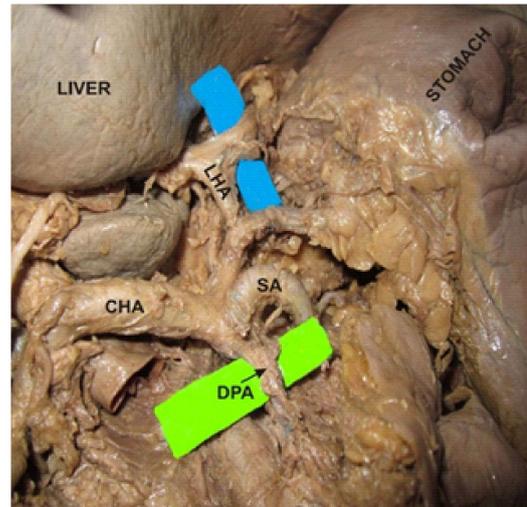
**Fig. 1:**Normal Branching Pattern Of Coeliac Artery.



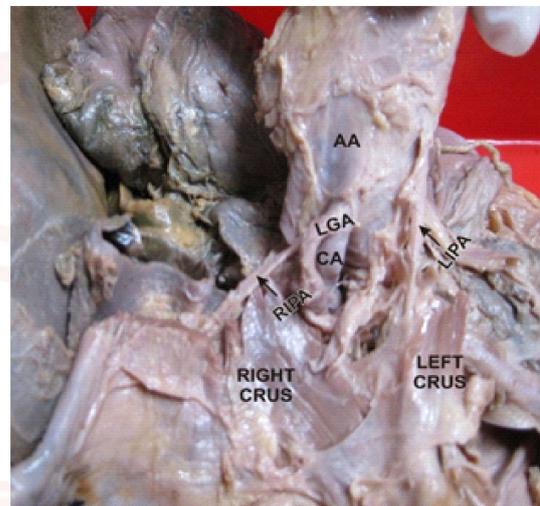
**Fig. 2:**Trifurcation Of Coeliac Artery.



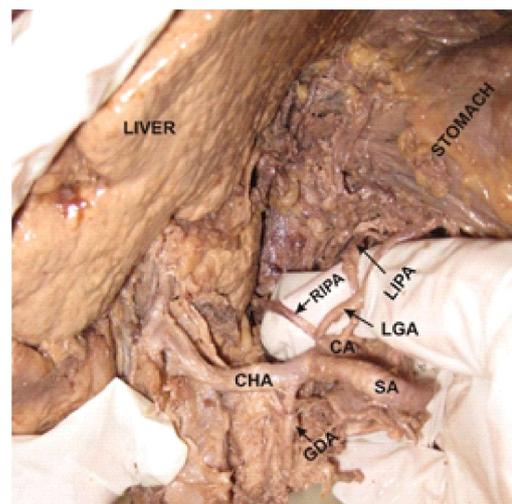
**Fig. 3:**Tetrafurcation of coeliac artery.



**Fig. 4:**Right inferior prenic artery from coeliac artery along with left gastric artery.



**Fig. 5:**Right and left inferior phrenic artery from coeliac artery



In 39(78%) specimens the coeliac artery gave origin to only its three classical branches. In 34(68%) specimens the coeliac artery bifurcated into hepatosplenic trunk with left gastric artery arising separately proximal to bifurcation (Fig. 1).

In 5(10%) specimens the coeliac artery trifurcated into its three branches (Fig. 2).

In 2(4%) specimens coeliac artery quadrifurcated into left gastric, splenic, common hepatic and dorsal pancreatic artery (Fig. 3).

In 6(12%) specimens right inferior phrenic artery arose from coeliac artery along with left gastric artery and left inferior phrenic artery arose from abdominal aorta (Fig. 4).

In 3 (6%) specimens both left and right inferior phrenic arteries arose from coeliac artery separately proximal to origin of left gastric artery (Fig. 5).

## DISCUSSION

**Type of coeliac artery:** In the present study it was observed that in 78% of the specimens the coeliac artery was complete and in 22% there were aberrant branches (in 18% inferior phrenic arteries were present and in 4%, dorsal pancreatic artery was present) arising from the coeliac artery in addition to the 3 classic branches which was similar to observations made by Muhammad Saeed et al[4], Pushpalatha et al[5], Selma Petrella et al studies (Table 1).

The previous studies reported incomplete coeliac artery and absent coeliac artery which was not observed in this study. This might be because of the racial and geographical factors.

Variations in the branching pattern of coeliac artery are usually asymptomatic. They become significant in patients undergoing coeliacography for gastrointestinal bleeding and prior to operative procedures in the abdomen[7].

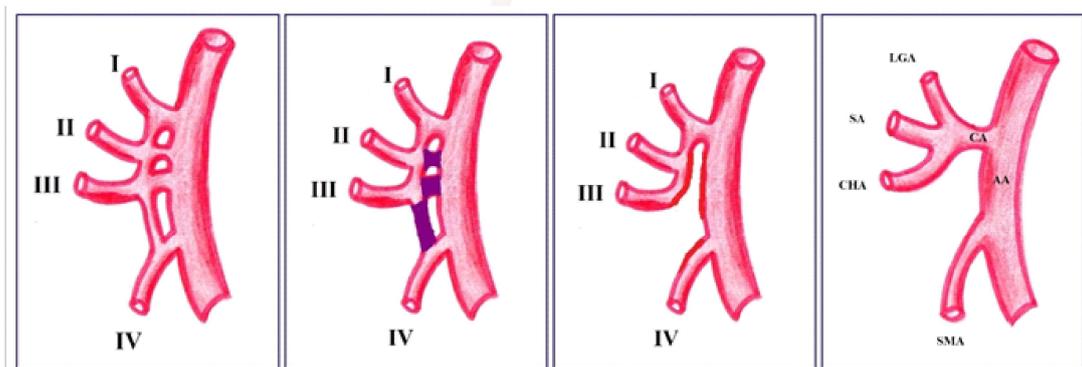
**Embryological relevance:** The coeliac artery develops from the ventral splanchnic arteries. The ventral splanchnic arteries are segmental branches originating from the dorsal aorta on each side and supply the primitive gut. Initially they are paired. During the fourth week of intra-uterine life, they become unpaired after the fusion of dorsal aortae. They are connected by longitudinal anastomotic channels along the dorsal and ventral aspects of the digestive tube. They form dorsal and ventral splanchnic anastomoses. After the formation of longitudinal anastomoses, only a few sub diaphragmatic ventral splanchnic arteries are needed. So their number is reduced to three- The coeliac artery, the superior mesenteric artery and inferior mesenteric artery. There are initially four roots of ventral splanchnic arteries connected by longitudinal anastomoses. The first three roots form the left gastric, splenic and common hepatic arteries and the fourth root forms the superior mesenteric artery. Usually the part of second and third root proximal to anastomosis disappears. The anastomosis between the third and the fourth root also disappears (Fig 6)

**Table 1:**Type Of Coeliac Artery.

Study	Complete	Incomplete	CM Trunk	Absent	Aberrant
Muhammad Saeed et al [2003]	88.30%	1.90%	-	-	9.60%
Pushpalatha [ 2006]	70%	4%	-	4%	22%
Selma Petrella et al [2007]	82.02%	6.60%	-	1.12%	7.86%
Present Study	78%	-	-	-	22%

CM trunk- coeliacomesenteric trunk

**Fig. 6:**Developmental Anatomy of coeliac artery.



**Table 2:**Incidence of LIPA and RIPA from CA.

Incidence of both the LIPA and RIPA from CA	Percentage
Muhammad Saeed et al [2003]	9.60%
Selma Petrella et al [2006]	5.62%
Ahmet Songur et al [2010]	4.20%
Present study	6%

LIPA- left inferior phrenic artery, RIPA- right inferior phrenic artery, CA- coeliac artery

**Table 3:** Incidence of RIPA From CA.

Incidence of RIPA alone from CA	Percentage
Selma Petrella et al [2006]	5.62%
Pushpalatha[2006]	4%
Mburu K S et al[2010]	4.90%
Present study	12%

**Table 4:**Incidence of DPA from CA.

Incidence of DPA from CA	Percentage
Pushpalatha [2006]	2%
Mburu K S et al [2010]	14.80%
Sunita U. Sawant et al [2013]	2%
Present study	4%

DPA- Dorsal pancreatic artery

This leads to origin of the left gastric artery, splenic artery, common hepatic artery from coeliac artery, which is formed from the first root. If there occurs any variation in this process like, the part that normally disappears does not do so, or the part that usually persists disappears, this leads to variation in the branching pattern of coeliac artery. This explains the reason for displacement of any of the classic branches of coeliac artery to superior mesenteric artery (usually common hepatic artery) or its branches directly arising from the aorta.

As the organs descend into the abdomen, origin of the arteries supplying them also descend by differential growth. This descent transfers the origin of coeliac artery from seventh cervical segment to twelfth thoracic segment [8].

**Incidence of origin of Inferior phrenic artery from coeliac artery:** In the present study the right inferior phrenic artery took origin from coeliac artery in 12% of the specimens, with left inferior phrenic artery taking origin from abdominal aorta. This finding differed from the previous studies. Both the inferior phrenic arteries took origin from coeliac artery separately proximal to its three classic branches in 6% of

the specimens in this study which was similar to the observations of Selma Petrella et al and Ahmet songur et al[9]. Inferior phrenic arteries enter the diaphragm, divide into branches and may communicate with the branches of hepatic arterial system, because of the common embryologic origin of liver and diaphragm from the septum transversum[11]. The inferior phrenic artery especially the right, is a major source of collateral blood supply to hepato cellular carcinoma[12,13]. Gokan et al observed dilated right inferior phrenic artery in patients with hepatocellular carcinoma[14]. It is essential to be aware of the variant anatomy of inferior phrenic arteries in haemoptysis due to pulmonary pathologies located in lung base. Left inferior phrenic artery provides oesophageal branches which irrigates the gastro oesophageal junction. Thus knowledge of its origin becomes significant in the event of gastrointestinal haemorrhage from gastro oesophageal junction[13,15].

The inferior phrenic arteries anastomose with the superior phrenic arteries in the thoracic diaphragm. It can be opened up in case of coeliac stenosis to revascularize the supra colic abdominal compartment when inferior phrenic artery originates from coeliac artery[10].

**Embryological relevance:** The inferior phrenic, adrenal and gonadal arteries are derivatives of original mesonephric arteries which are primitive lateral branches of aorta in human embryo. Thus combination in the origin of these former vessels can be expected which lead to variation in the origin of inferior phrenic arteries from several sources. Broman has emphasized that the mesonephric arteries may originate at variable points from the lateral aortic circumference. Many of them are ventrolateral derivatives. Further differential growth of the lateral aortic circumference may result in incorporation of the mesonephric artery with the ventral branch of the aorta, thus resulting in origin of inferior phrenic artery from coeliac artery[16].

**Incidence of origin of dorsal pancreatic artery from coeliac artery:** The dorsal pancreatic artery and splenic artery are the main source of vascular supply to the tail of the pancreas. When the dorsal pancreatic artery emerges from

coeliac artery instead of its usual splenic origin, it can be missed by surgeons who are not aware of its variant anatomy. This can affect the vascular supply of tail of pancreas and damage the pancreatic graft after reperfusion if not recognised during back table inspection[18]. In the present study dorsal pancreatic artery emerged from coeliac artery in 4% of the specimens, similar to the observation made by Sunita Sawant et al and Pushpalatha et al. Iatrogenic injury of dorsal pancreatic artery due to lack of prior expertise in its variant anatomy can cause ischemia and necrosis of the part of the pancreas it irrigates resulting in serious post operative complications[19]. Dorsal pancreatic artery is one of the source of post pancreatectomy haemorrhage which is treated by transcatheter arterial embolization. Hence knowledge regarding its origin becomes mandatory to successfully treat post pancreatectomy haemorrhage[20].

Dorsal pancreatic artery is also used as a conduit for infusion of autologous bone marrow derived stem cells for treatment of diabetes mellitus[21].

## CONCLUSION

The importance of anatomy of visceral vasculature has increased dramatically in recent times. Its value has increased immensely with the introduction of laparoscopic procedures where surgical field of vision is limited and mistakes are common. Ligation of a variant artery with subsequent ischemia of the part it irrigates can have serious consequences on the patient. The importance has increased further with the introduction of organ transplantation. In the era of computerised surgery anatomy becomes indispensable.

## ABBREVIATIONS

**AA-** Abdominal Aorta

**CA-** Coeliac artery

**CHA-** Common Hepatic Artery

**DPA-** Dorsal Pancreatic Artery

**GDA-** Gastro Duodenal Artery

**LGA-** Left Gastric Artery

**LIPA-** Left Inferior Phrenic Artery

**RIPA-** Right Inferior Phrenic Artery

**SA-** Splenic Artery

**SMA-** Superior Mesenteric Artery

**PV-** Portal vein

**Conflicts of Interests: None**

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