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Original Research Article

# A cadaveric study on Celiac Trunk branching pattern variations and it's clinical significance in a teaching hospital setting

Dr. Thanuja Ande
Assistant Professor, Department of Anatomy, Government Medical College, Mahabubnagar Metugadda, Mahabubnagar District, Mahbubnagar, Telangana 509001, India

***Corresponding author:** Dr. Thanuja Ande
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## Abstract

Coeliac artery anatomy has an implication on diseases, thus a grasp of the variations in the branching pattern plays the role in the assessment of the patient. This work is undertaken to study the anatomical features of coeliac trunk like length, branching pattern and it's anatomical variations in Rayalaseema zone of Andhra Pradesh in view of great medical and surgical importance of it. The study was conducted in the department of Anatomy of Kurnool Medical college and hospital, Kurnool, Andhra Pradesh. Of the 50 specimens, manual dissection was done in 22 dissection hall cadavers and manual dissection was done in the 28 post mortem specimens regarding the origin of the coeliac trunk and its arteries. The various patterns were normal hepatolienogastric trunk in 92%, lienogastric trunk in 2%, hepatolienomesenteric trunk in 2%, coeliaco-colic trunk in 2%. 96% of specimens had complete coeliac trunk and 4% had incomplete coeliac trunk. Tripod was seen in 38% of the specimens. The supernumery branches were observed from coeliac trunk were inferior phrenic artery in 32%, dorsal pancreatic artery in 12%, superior mesenteric artery in 2% and middle colic artery in 2%. Knowledge of such variations in branching pattern of the celiac trunk is essential for liver and pancreas transplantations, pancreaticoduodenectomy, radiological abdominal interventions, laproscopic surgeries, and in trauma of the abdomen.
**Keywords:** Hepatolienogastric trunk, coeliac trunk, tripod, phrenic artery.



## INTRODUCTION

Coeliac trunk is one of the branches in the abdominal aorta which shows several variations in its branching pattern. The knowledge about arterial supply of the upper abdominal organs zsis very important. Anatomical variations in coeliac trunk branching pattern are of considerable importance in liver transplants, laproscopic surgery, radiological abdominal interventions, and penetrating injuries of the abdomen and chemoembolization of pancreatic and liver tumours. Careful identification and dissection of the coeliac trunk branches is therefore important to avoid iatrogenic injury [1]. Anatomic variations which involves the visceral arteries were common [2]. The size of the left gastric artery may be double and it will origin separately from abdominal aorta. Variations are identified in it's origin of the left gastric artery from aorta instead from coeliac trunk. This may be useful to the surgeons during gastric case's treatment. Splenic artery originate from the abdominal aorta or the superior or inferior mesenteric arteries, it may take it's origin either from middle colic or left hepatic artery. A good knowledge of anatomy of splenic artery is very much essential during splenectomy, percutaneous interventional techniques such as partial splenic artery embolization, stent placement, etc.

Commonly, hepatic artery will origin either from abdominal aorta/superior mesenteric artery. Left hepatic artery sometimes originated from left gastric artery. The origin of hepatic artery as direct branch from the aorta and superior mesenteric artery from the coeliac trunk must be understood by the gastroenterologist. The rare origin of middle colic artery from coeliac trunk must also be known by the surgeons because careless ligation of which may lead to the ischemic necrosis of the right two-thirds of the transverse colon.

Knowledge of the variation of vascular anatomy of the liver and stomach and its relation to the lymph nodes is required for gastroenterologists. Because lymphatic metastasis in carcinoma of stomach require dissection of nodes along these arteries, for which both normal and variational vascular anatomy is much essential.

Obstruction in the hepatic artery which proximal to right gastric artery will saves liver from

necrosis because of an establishment of collateral circulation between gastric and gastroepiploic arteries. But, when the occlusion affects the hepatic artery proper the necrosis of liver is invariable [3].

In about 20% of people, part of the origin of coeliac axis was compressed through median arcuate ligament, results in the median arcuate ligament syndrome. This type of syndrome wil almost confined to the women. Aortogram will shows the compression of coeliac artery by median arcuate ligament [4].

Coeliac artery aneurysm, rare splanchnic artery aneurysm may leads to high risk mortality if they rupture. The management to this aneurysms was challenging, when they are large and they involves the confluence of the trifurcation [5].

In addition, three dimensional and multiplanar imaging offer detailed noninvasive analysis of the coeliac trunk and its branches. Overall, the benefits of MDCT can aid in planning for surgeries and other clinical interventions.

Presence of arterial variations may result in erroneous interpretation of angiograms. The topographical anatomy of such variations is also important for interventional radiologists performing arteriography [6].

Because of these surgical importance and the existence of wide variations in the arterial supply of supramesocolic organs and its need for surgeons, radiologists and anatomists, the study on coeliac trunk and its branches had been undertaken.

Hideki katagiri *et al.,* reported the condition of multiple arterial anomalies in Japan female patient cadaver during a routine dissection course. A combination of three arterial anomalies were identified in abdominal digestive organs like a coeliacomesenteric trunk; a right accessory hepatic artery; and a left colic artery which arises from the portion corresponding to superior mesenteric artery [7].

Ugurel, MD *et al.,* reported coeliac trunk and or hepatic artery variation in 23 (39.7 %) of the 58 patients with no renal artery variation, 27 (64.3%) of 42 patients with renal artery variations [8].

Chiung-Ying Liao *et al.,* described an isolated spontaneous dissection of the coeliac artery with aneurysm formation in a man with acute onset of abdominal pain and a history of hypertension and hyperlipidemia using multi detector computed tomography [9].

Sathidevi. V. K *et al.,* reported the variations in coeliac trunk which 0found during routine dissections. They reported quadrification of coeliac trunk into splenic, hepatic, left gastric and gastroduodenal which is a very rare variation [6].

Sunita U. Sawant *et al*., demonstrated the variations in the branching pattern of coeliac trunk adult cadavers. The left gastric artery arises as first branch of coeliac trunk and then the trunk bifurcates into splenic and hepatic arteries. Right gastric artery is observed originate from left hepatic artery [10].

The knowledge of the variations in hepatic artery is important in liver transplantation, laparoscopic surgeries, partial hepatectomy, gastric resection, pancreatico-duodenectomy, radiological interventions and penetrating injuries to the abdomen. Furthermore the arterial variations are also important when matching organ procurements for transplantation.

## MATERIALS AND METHODS

This study was conducted in department of anatomy, Kurnool medical college, kurnool.

The study conducted in 50 human cadaveric specimens. Of these, 22 specimens were done in the dissection hall cadavers, 28 post mortem bodies were collected from the department of Forensic Medicine of the same college hospital.

**Collection of Specimens:**

Post mortem specimens were collected from the Department of Forensic Medicine, Kurnool Medical College, Kurnool. By an I-shaped incision extending from the suprasternal notch to pubic symphysis, anterior chest wall was opened. The heart and lungs were removed from the thorax. The thoracic aorta, thoracic part of inferior vena cava and oesophagus were tied, cut and removed proximally. Distally the abdominal aorta and inferior vena cava were tied and cut below the level of origin of the renal arteries and removed along with abdominal diaphragm, liver, spleen, stomach and pancreas in total. The specimens were washed in the running water 300 – 400 ml of 10% formalin was injected through one cut end of the abdominal aorta using a 20 ml syringe and then the specimens were completely immersed in the buckets containing 10% formalin solution and were preserved for 10 days.

## METHOD OF STUDY

**In Dissection Hall Specimens**

Manual dissection was done in 22 dissection hall cadavers. According to the textbook of Cunningham's manual of Practical Anatomy, abdominal cavity was opened by cutting and reflecting the muscles of anterior abdominal wall. The anterior layer of lesser omentum was removed which close to the lesser curvature of stomach and left gastric artery was traced along its gastric and oesophageal branches. The branches of the proper hepatic artery are traced. The gastroepiploic arterial arcade in the greater

omentum was identified and dissected. The anterior layer of the greater omentum was cut 2.3 cm inferior to the arteries and the omental bursa was opened. The stomach, right gastric and gastro-epiploic vessels were cut immediately to the left of the pylorus and turned to the left. The coeliac trunk was identified. The dense autonomic plexus around the trunk and its branches were removed and the branching pattern had been noticed. The splenic artery was traced along the superior border of pancreas and its branches were noticed. All the findings were recorded.

**In Post-Mortem Specimens**

Manual dissection was done in the 28 post mortem specimens regarding the origin of the coeliac trunk and its branches. The arteries supplying the liver, stomach, pancreas and the spleen were dissected according to the above said procedure and the findings were recorded.

## RESULTS

**COELIAC TRUNK**

**Origin:**

In all the 50 specimens, coeliac trunk took origin from the ventral surface of the abdominal aorta just below the crura of the diaphragm.

**Direction of Inclination:**

In 49 specimens, coeliac trunk most inclined towards the right side and passed forwards and downwards. In 1 specimen, coeliac trunk inclined more towards left side. It was Lienogastric trunk with replaced common hepatic artery from aorta. This inclination to the left side was due to the absence of the pull exerted by coeliacal hepatic artery.

**Pattern of Coeliac Trunk**

*Hepatolienogastric trunk*: In total of 46 samples, the coeliac trunk will divide into common hepatic artery, left gastric artery and splenic arteries as standard classification pattern.

*Lienogastric trunk: In o*ne specimen, the coeliac trunk was branched in to left gastric artery and splenic artery with left inferior phrenic artery as a supernumery branch. The common hepatic artery originated from aorta, the little below the origin of the lienogastric trunk.

*Hepatolienomesenteric trunk:* In one specimen, the common hepatic artery, splenic artery and superior mesenteric artery originated together as hepatolienomesenteric trunk with dorsal pancreatic artery as a supernumery branch from it. The left gastric artery had replaced origin directly from the aorta, a little above the origin of hepatolienomesenteric trunk and it gave both inferior phrenic arteries leading to the formation of the gastrophrenic trunk.

Coeliaco-colic trunk: In one specimen, it was noted that the coeliac trunk apart from dividing into common hepatic, left gastric and splenic arteries, it also gave origin to middle colic artery. The middle colic artery descended down in the transverse mesocolon and supplied the right two-third of the transverse colon by its vasa rect.

**Coeliac trunk is dividing into hepatic and splenic arteries**

In one specimen, it was observed that the coeliac trunk was divided into splenic artery and common hepatic artery. The left gastric artery may originating from the splenic artery.

Complete and Incomplete coeliac trunk: Coeliac trunk resulting to origin to the left gastric aartery, hepatic artery and splenic artery, which is known as the complete trunk. Coeliac trunk without any of these 3 arteries was known as incomplete coeliac trunk. In this study, 96% of specimens had complete trunk (arteries) and only 4% of specimens had incomplete coeliac trunk (lienogastric and hepatolienomesenteric trunk).

Tripod of Haller: Coeliac trunk dividing into common hepatic, left gastric and splenic arteries simultaneously at a common point is known as Tripod of Haller. Such type of Tripod of Haller was observed in 19 specimens of the present study.

**Supernumery Branches of Coeliac Trunk**

In 24 specimens, Supernumery branches from coeliac trunk were observed. The Supernumery branches were:

Inferior phrenic artery: In 16 specimen samples, the inferior phrenic artery resulting origin from the coeliac trunk. In these 16 specimens, 10 specimens in which the left inferior phrenic artery was originated from the celiac trunk. In 2 specimens, the right inferior phrenic artery originated from celiac trunk. In 3 specimens, both right and left inferior phrenic arteries arose from coeliac trunk. In 1 specimen, coeliac trunk gave a common trunk which in turn divided into right and left inferior phrenic arteries.

Dorsal pancreatic artery: In six specimens, it was observed that the origin of dorsal pancreatic artery was arising from the celiac trunk. In total of 6 specimens, the artery coursed posterior to the head of the pancreas and entered into the uncinate process.

***Superior mesenteric artery:*** In one specimen, it took originating from the coeliac trunk.

***Middle colic artery:*** In one specimen, it was observed that the middle colic artery resultis in the origination from the celiac trunk. It was coursed in the transverse mesocolon and also supplied the right two third of the transverse colon by its vasa recta.

**Length:** The length of the coeliac trunk ranged from 1.1 to 2.3 cm. The number of specimens having variable length was tabulated. The maximum number of specimens had the length ranged from 1.1 to 2.0 cm.

## DISCUSSION

The anatomy of coeliac trunk and its branches studied in 50 specimens were compared with the previous studies.

In Gray's Anatomy textbook, it was stated that the celiac trunk is the ventral branch of the aorta, which dividing into the left gastric artery, common hepatic artery and splenic artery. In our study, it was also shown that the coeliac trunk may origin from the ventral surface of the aorta in total 50 specimens. Rossi [11], Yamaki *et al.*,[12], Higashi N *et al.*,[13], Basar *et al.*,[14], Murakami T *et al.*, [15], Peschaud F *et al*., [16] have noticed absence of coeliac trunk and all the three branches took separate origin from aorta. But in the present study, coeliac trunk was not absent in any of the 50 specimens.

**Direction of Inclination**

Vandamme JP Bonte J [17] observed the inclination of celiac trunk unusually to the left is due to absence of the pull exerted by coeliacal hepatic artery. In the present study, the above finding was observed in 1 specimen.

**Pattern**

The various pattern of coeliac trunk were:

**Hepatolienogastric Trunk:**

Lipshutz [18] had observed this type of trunk in 75% out of 83 cadavers, Adachi [19] in 87.7% out of 252 specimens, Michels in 89% out of 200 specimens, Shoumura S *et al.*, [20] in 90.2% out of 184 specimens. In our study, its incidence is 92% out of 50 specimens, which is closely similar to Shoumura S *et al.*, [20] study.

**Lienogastric Trunk**

Lipshutz [18] found this type in 4% specimens, Michels [21] in 2%, Shoumura S *et al.*, [20] in 1.09% of specimens. In the current study, it was noticed in 1 specimen – 2% incidence, which is similar to Michels study.

**Hepatolienomesenteric Trunk**

This type of trunk had been reported by Adachi [19] in 1.2%, Michels [21] in 0.5%, Shoumura S *et al.*, [20] in 1.09%. This trunk was seen in 1 specimen in the present study - 2% of specimens, which is closely similar to Adachi's study.

**Table-1: Various Pattern of Coeliac Trunk and its Percentages**

| Sl. No | Pattern | No. of Specimens | Percentage |
|---|---|---|---|
| 1. | Hepatolienogastric trunk | 46 | 92% |
| 2. | Lienogastric trunk | 1 | 2% |
| 3. | Hepatolienomesenteric trunk | 1 | 2% |
| 4. | Coeliaco-colic trunk | 1 | 2% |
| 5. | Coeliac trunk dividing into hepatic and splenic artery | 1 | 2% |

**Table-2: Various Pattern of Coeliac Trun**

| Sl. No | Name of the authors | Year of Study | No. of specimns | Hepatolieno Gastric trunk | Lienogastric trunk | Hepatolieno mesenteric trunk | Coeliaco colic trunk |
|---|---|---|---|---|---|---|---|
| 1. | Lipshutz | 1917 | 83 | 75% | 4% | - | - |
| 2. | Adachi | 1928 | 252 | 87.7% | - | 1.2% | - |
| 3. | Michels | 1955 | 200 | 89% | 2% | 0.5% | 0.5% |
| 4. | Shoumura S *et al.*, | 2001 | 184 | 90.2% | 1.09% | 1.09% | - |
| 5. | Present study | 2011 | 50 | 92% | 2% | 2% | 2% |

**Coeliaco-colic Trunk**

This rare variation had been reported by Michels [21] in which the origin of middle colic artery from coeliac trunk was found in 1 out of 200 specimens - 0.5%. In our study, it was noticed in 1 out of 50 specimens - 2%, which is closely similar to the above study.

**Others**

Hepatogastric trunk was observed by Lipshutz [18] in 6%, Michels [21] in 0.5%. Coeliaco mesenteric trunk was reported by Adachi [19] in 2.4%, Michels [21] in 0.4%. In our study, hepatogastric and coeliaco mesenteric trunk was not observed.

**Complete and Incomplete Coeliac Trunk**

Eaton [22] observed complete coeliac trunk in 86% and incomplete trunk in 12.5% of specimens. Lipshutz [18] reported complete coeliac trunk in 75% and incomplete in 25%. In the current study, complete coeliac trunk was seen in 96% and incomplete in 4% of specimens.

**Tripod of Haller**

The three branches of coeliac trunk trifurcating from a common point had been observed by Eaton [22] in 15.5% and by Michels [21] in 20% of specimens. In our study, the Tripod of Haller was observed in 38% of specimens.

**Supernumery Branches**

*Inferior Phrenic Artery:* Study by Pick and Anson [23], showed in 47.8% out of 200 cadavers observed the originating inferior phrenic artery from coeliac trunk. Study by Piao Dx *et al.*, [24] demonstrated that this incidence of inferior phrenic artery taking originating from coeliac trunk was 28.2%. In our study, in 32% of the specimens, the inferior phrenic artery took origin from the coeliac trunk as supernumery branch, which is closer to Piao Dx study.

Saeed M *et al.*, [25] reported a case in which a common inferior phrenic artery taking origin from coeliac trunk and then dividing into right and left inferior phrenic artery. Such type of common inferior phrenic artery was observed in 1 in 50 specimens (2%) in the our study.

Cicekcibasi AE *et al.*, [26] reported a case in which both inferior phrenic arteries took origin from coeliac trunk separately. In our study, the same variation had been recorded in 3 specimens - 6%.

**Dorsal Pancreatic Artery**

Eaton [22] in 11.2%, Michels [21] in 5%, Dr. Kalavathy [27] in 10% of specimens reported dorsal pancreatic artery arising as a branch of coeliac trunk. In our study, the incidence was 12% which is closely similar to Dr. Kalavathy's study.

**Superior Mesenteric Artery**

Adachi [19] in 1.2%, Michels [21] in 0.5% of specimens observed the superior mesenteric artery arising from coeliac trunk. In our study, the same was observed in one specimen - 2%, which is closely similar to Adachi's study.

**Middle Colic Artery**

Michels [21] observed the origin of middle colic artery from coeliac trunk in 0.5%. In our study too, it was observed in one specimen (2%).

**Table-3: Supernumery Branches from Coeliac Trunk with Percentages**

| Sl.No | Name of the artery | No. of specimens | Percentage |
|---|---|---|---|
| **1.** | **Inferior phrenic artery:** | 16 | 32% |
| | a. Left Inferior phrenic artery | 10 | 20% |
| | b. Right Inferior phrenic | | |
| | artery | 2 | 4% |
| | c. Both right and left inferior | | |
| | phrenic | 3 | 6% |
| | artery - separate origin | | |
| | d. Both right and left inferior | 1 | 2% |
| | phrenic | | |
| | artery – origin from a | | |
| | common trunk | | |
| **2.** | **Dorsal pancreatic artery** | 6 | 12% |
| **3.** | **Superior mesenteric artery** | 1 | 2% |
| **4.** | **Middle colic artery** | 1 | 2% |

In Gray's Anatomy textbook, it was stated that the length of the coeliac trunk was 1.5 cms to 2 cms. In Anatomy for Surgeons textbook by Hollinshead, it was also stated that it's length is 1 to 3 cms. In our study it was identified that, the length of the coeliac trunk ranged from 1.1 cms to 2.3 cms.

**Table-4: Length of the Coeliac Trunk**

| *Length (cm)* | *No. of specimens* |
|---|---|
| **1.0 to 1.5** | **24** |
| **1.6 to 2.0** | **22** |
| **2.1 to 2.5** | **4** |

Michels [21] classified coeliac trunk into 7 types. Out of 200 speicmens 89%, 3.5%, 0.5%, 5.5%, 0.4%, 1% specimens belongs to classification type I, type II, type III, type IV, type V, type VI, type VII respectively. Whereas, our study, out of 50 specimens, 92% belonged to type I, 2% belongs to type II, 2% belongs to type III, 2% belongs to type V and 2% belongs to type VII respectively. Classification type IV and type VI coeliac trunk were not observed in the study.

## CONCLUSION

The various patterns were normal hepatolienogastric trunk in 92%, lienogastric trunk in 2%, hepatolienomesenteric trunk in 2%, coeliaco-colic trunk in 2%. In our study out of 50 specimens 92%

belonged to Type I, 2% to Type II, 2% to Type III, 2% to Type V, 2% to Type VII. Type IV and Type VI Coeliac trunk were not observed. The most common pattern of branching of the Coeliac trunk was the Hepatogastrolienal type, which has been accepted as the normal pattern of branching of the Coeliac trunk. 96% of specimens had complete coeliac trunk and 4% had incomplete coeliac trunk. Tripod was seen in 38% of the specimens. The length ranged from 1.1 to 2.3 cm. The supernumery branches observed from the coeliac trunk were inferior phrenic artery in 32%, dorsal pancreatic artery in 12%, superior mesenteric artery in 2% and middle colic artery in 2%.

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