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Original article

Morphometry of the celiac trunk: a multidetector computed tomographic angiographic study

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KEYWORDS

Celiac trunk, Variations, Angiography, Computerized tomography.

ABSTRACT

Aims: We carried out this study for evaluating the normal anatomy trunk and prevalence of anatomical variations of celiac trunk in the North Indian population. *Materials and methods*: Computerized tomographic images of 50 North Indian subjects, obtained from the Department of Radiodiagnosis, King George's Medical University, were retrospectively analyzed. The anatomy of the celiac trunk was studied using dynamic scans. *Results*: A variation in the site of origin of celiac trunk was observed in about 55% cases. The length and dimensions of the trunk also displayed a wide range of variation. *Conclusion*: Anatomic variations of the celiac trunk as observed by us may become important in patients undergoing diagnostic angiography for gastrointestinal bleeding or prior to an operative procedure. Recognition of variations would enable clinicians to distinguish features which merit further investigations or treatment from those which do not.

1. Introduction

The celiac artery (CA) (also called the celiac trunk) and its branches supply the gastrointestinal (GI) tract from the distal third of the esophagus to the mid-part of the duodenum and all derived adnexae (liver, biliary tree, spleen, dorsal pancreas, greater omentum, and lesser omentum). The celiac artery/trunk, the first ventral branch of aorta, arises below the aortic hiatus at the junction between the T12/L1 vertebrae and has a length of about 1.5–2 cm. It courses horizontally forward and divides into left gastric artery (LGA), common hepatic artery (CHA), and splenic artery (SA). Celiac arterial anatomy, therefore, most commonly consists of a hepatogastrosplenic trunk with a classical branching trifurcation referred to as the *'Tripus halleri'*.[1]

The celiac trunk is subject to morphological variability. Previous studies have suggested anomalies in the CA origin, dimensions, branching pattern, and origin of its branches.[2,3] The celiac trunk has been described to arise variably at the 12th thoracic vertebrae,[4] between the T12–L1 vertebrae[5] and at the level of the T11–T12 vertebrae.[6] The length and diameter also show variability; length ranging from 5 mm to 40 mm has been reported by Rio Branco,[7] 1 cm to 2 cm by Tandler,[8] and 10 mm to 15 mm by Latarjet and Ruiz-Liard.[9] The diameter was found ranging from 4 mm to 10 mm,[7] 10 mm to 12 mm,[10] and 6 mm on average.[9]

Studies have also suggested anomalies in the branching pattern of the celiac trunk which include other patterns of branching besides classical trifurcation. One of the components of the celiac trunk may sometimes arise directly from the abdominal aorta. On rare occasions, the celiac trunk may be *completely absent* and all three components then branch off independently from the aorta.

Owing to recent advances in the technology of spiral and multidetector computed tomography, thin-section dynamic CT has replaced conventional angiography for preoperative

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imaging.[11] Rawat has commented that multislice CT is an excellent modality for pre-operative evaluation of vascular anatomy and it is safe, cost effective, time saving, and highly accurate.[12]

Therefore, we planned to evaluate the normal anatomy and variants of the celiac artery, with the help of computed tomographic angiography.

2. Materials and methods

In the present study, we examined 50 subjects including both males and females in the age group between 18 months and 78 years. This cross-sectional study was carried out after approval by our institutional ethical review board. The study was conducted in the Departments of Anatomy and Radiodiagnosis, King George's Medical University, Lucknow, UP.

All subjects undergoing the computed tomographic angiography of the abdominal aorta, for any medical or surgical indications, were included in the study group.

Exclusion criteria included any person who was allergic to iodine, unable to hold breath for 20 s, suffering from aortoarteritis, collagen vascular disorder, had a positive history of previous abdominal surgery, or was suffering from abdominal malignancy which was likely to distort the vascular anatomy.

2.1 *Angiography images*

Computed tomographic angiography was performed on a multislice spiral CT scanner. Images were obtained and then evaluated on a computer workstation in the standard transverse plane. The images were also reformatted using computer software utilizing various image processing techniques. The normal anatomy and variations were studied on the 3D reformatted images. The axial images were used for final confirmation of variant anatomical findings.

3. Observations and results

3.1 *Level of origin (Figs. 1[a]–[d])*

The celiac trunk was found to originate at various levels ranging from the T-11 to L-1 vertebra. The site of origin of the celiac trunk in majority (45.83%) (Fig. 1[a]) was the junction of T12–L1 vertebrae. The CA originated opposite the T12 vertebra in 29.17% (Fig. 1[b]), opposite the L1 vertebra in 22.92% (Fig. 1[c]), and at the T11–T12 junction in 2.08% cases (Fig. 1[d]). The findings are depicted in Table 1.

3.2 *Variations in length and diameter*

The length of the celiac trunk was measured from the point of origin from the aorta up to the origin of its first branch.

Table 1 – Various vertebral levels of origin of the celiac trunk.

Vertebral level of origin	Males (n = 28)	Females (n = 20)	Total (n = 48)	
	No.	No.	No.	%
T11–T12	0	1	1	2.08
T12	9	5	14	29.17
T12–L1	14	8	22	45.83
L1	5	6	11	22.92

Celiac trunk was absent in two cases.

The length of the celiac trunk ranged between 6 mm and 22 mm. The diameter of the celiac trunk was measured in its first centimeter near its origin. The diameter of the celiac trunk was found to range between 4 mm and 10 mm.

3.3 *Branching patterns*

Among the 50 subjects studied, *trifurcation* was found in 28% (Fig. 2), *absent* celiac trunk was found in 4% (Fig. 3), and the rest 68% displayed other patterns of branching (Fig. 4). The observed prevalence is depicted in Table 2.

Table 2 – Different branching patterns of the celiac trunk.

Celiac trunk morphology	Males (n = 29)	Females (n = 21)	Total (n = 50)	
	No.	No.	No.	%
Absent celiac trunk	1	1	2	4
trifurcation	8	6	14	28
Other branching patterns	20	14	34	68

4. Discussion

The celiac trunk is the chief artery of the foregut. Its branches, namely left gastric, common hepatic, and splenic arteries, supply the primary organs of the supracolic abdominal compartment which includes the stomach, pancreas, duodenum, spleen, and liver.[13] Knowledge of its variations is important in the accurate interpretation of disease, in diagnostic imaging, as well as in deciding the optimum elective procedure in surgical or interventional radiological management.[14]

In our study, the celiac trunk displayed origin at various levels ranging from the T-11 to L-1 vertebra. Similar variations of origin have been previously reported by authors with varying frequencies of origin at different levels.[5,6,15] A high celiac trunk origin may give rise to the celiac axis compression syndrome (CACS) presenting with intense postprandial epigastric pain, nausea, and vomiting. We did not report any case of high origin of celiac trunk with celiac axis compression. Variability in the level of origin suggests that treatment planning for carcinoma of stomach, pancreas, and the

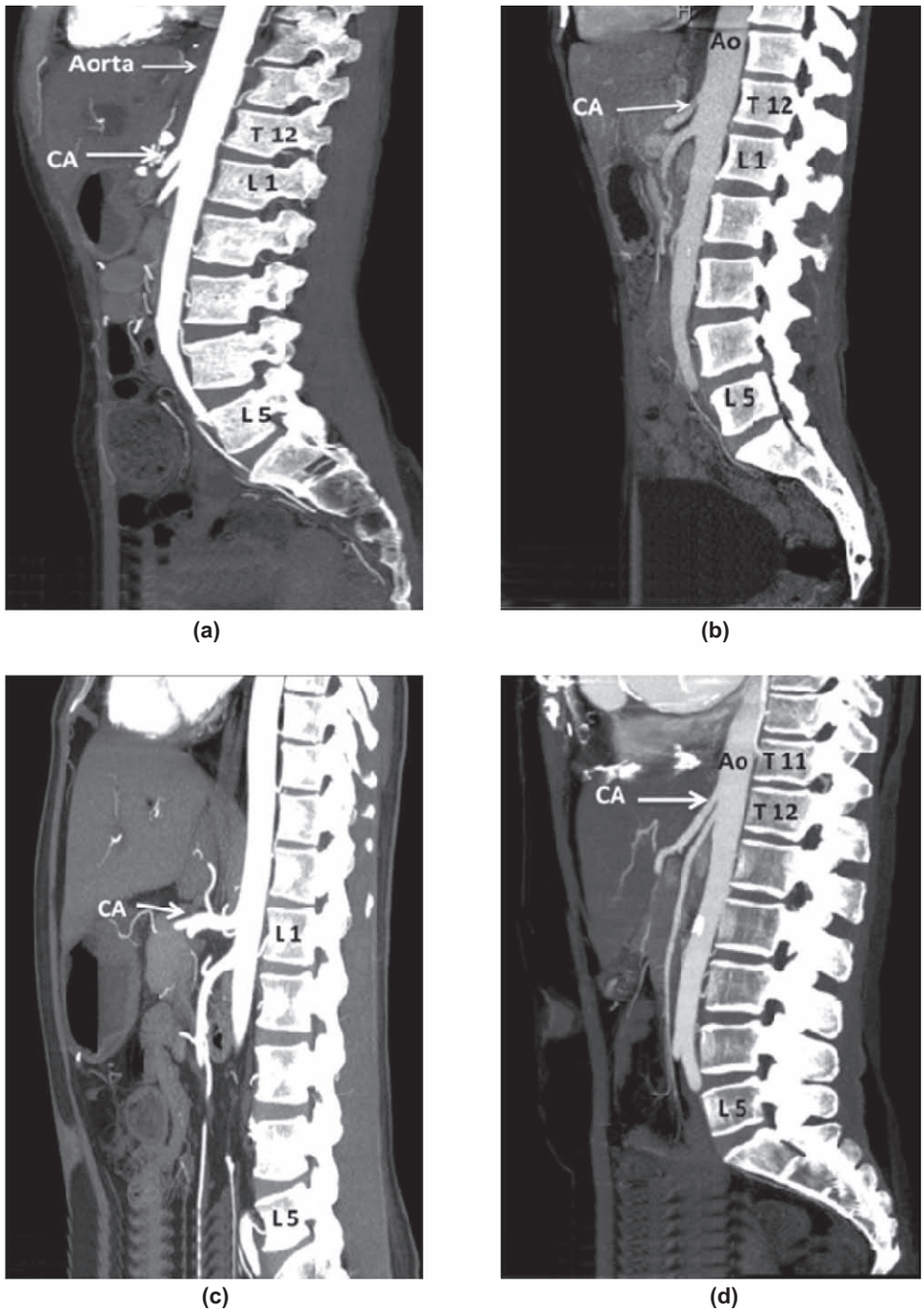

Fig. 1 – Sagittal reformat of multislice CT angiogram displaying (a) celiac trunk origin opposite T12–L1 junction, (b) celiac trunk origin opposite T12 vertebra, (c) celiac trunk origin opposite L1 vertebra, and (d) celiac trunk origin opposite T11–T12 junction: T – Thoracic vertebra, L – Lumbar vertebra.

hepatobiliary tree should be individualized as the lymph nodes at risk lie adjacent to this vessel.

The length of the artery ranged between 6 mm and 22 mm. Our finding was in accordance with that of Moncada et al,[16] Latarjet and Ruiz-Liard,[9] and Wadhwa and Soni.[15] The diameter of the celiac trunk was found to range from 3 mm to 12 mm which is in near agreement with that by Moncada et al,[16] who reported a range between 8 mm and 16 mm.

We observed a wide variation in the branching spectrum of celiac trunk within our study group. In the present study, we observed a higher prevalence of *other branching patterns* (68%) in comparison to classical *trifurcation*. Prevalence of tri-

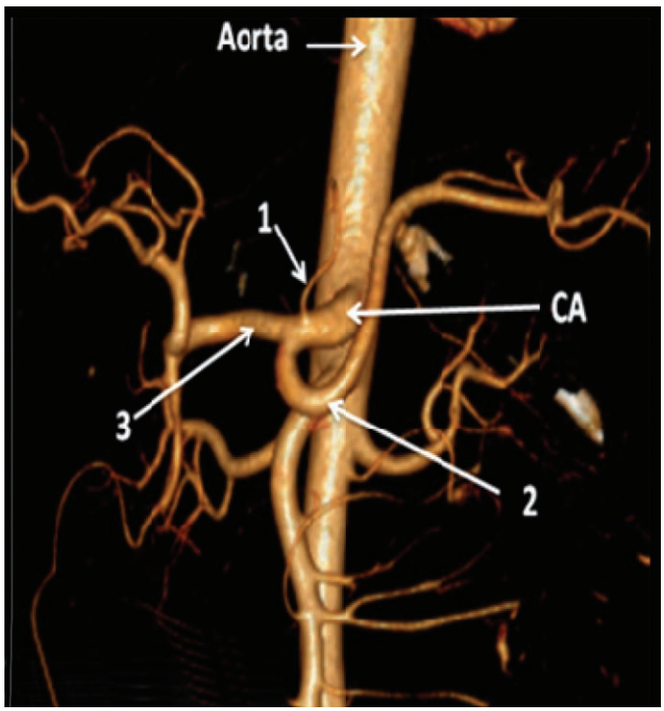

Fig. 2 – Computerized tomographic volume rendered image showing classical trifurcation of celiac trunk. The arrow shows the CA – celiac trunk: 1 – Left gastric artery; 2 – Splenic artery; 3 – Common hepatic artery.

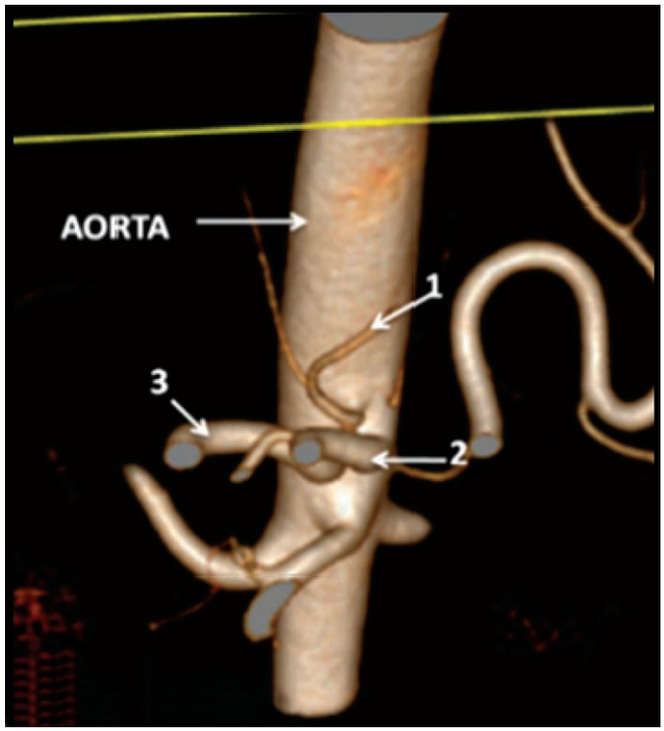

Fig. 3 – Volume-rendered image showing the absent celiac trunk with all three branches numbered: 1 (LGA), 2 (splenic artery), and 3 (CHA) originating from the aorta.

furcation observed by us was lower than that by Vandamme and Bonte,[1] who reported 86% trifurcation in an angiographic study, Iezzi et al,[17] who reported a classical configuration of the celiac trunk anatomy by multidetector row CT angiography in 72.1%, and Winston et al,[18] who reported trifurcation in 51% cases. According to Yamaki et al,[19] there are scanty reports of the absence of celiac trunk in the literature although we observed a higher prevalence (4%) of absence of celiac trunk in our study. Various types of studies which include cadaveric, angiographic, as well as intraoperative observations reported a prevalence ranging between 0.1%[20] and 2%.[21]

The arterial supply of the GI tract develops in week 4 of embryological life. The future blood vessels of the GI tract are formed from the vitelline system which is composed of bilateral arterial plexuses which coalesce to form arteries from the dorsal aorta to the GI tract. The anatomical variation in the celiac trunk is assumed to be caused by different patterns of vitelline reduction.

Vascular anomalies are usually asymptomatic but may become important in patients undergoing surgical, oncologic, or interventional procedures, diagnostic angiography for GI bleeding, CACS, or prior to an operative procedure or transcatheter therapy.[22] Arterial variations should be taken care of during the abdominal operative procedures on the stomach, duodenum, and pancreas.[23] Variations of the celiac trunk must be carefully understood in anastomosing the proper arteries in the liver. Presurgical planning of vascular anastomosis and variations is a key component for a variety of liver surgeries, including transplantation, tumor resection, and laparoscopic hepatobiliary surgery.[24]

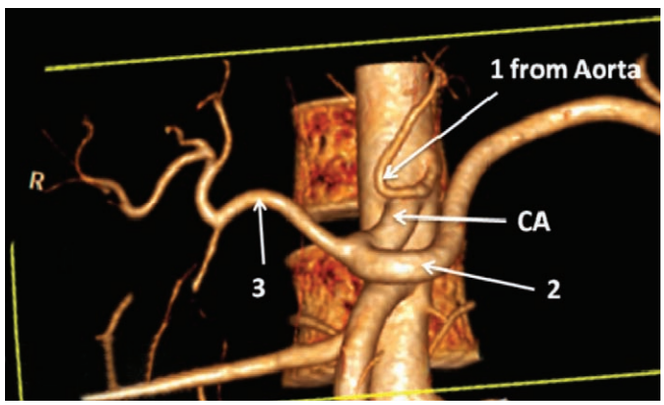

Fig. 4 – Volume-rendered computerized tomographic image showing bifurcation of the celiac trunk giving origin to arrows 2 (splenic artery) and 3 (CHA). Arrow 1 (LGA) originates directly from the aorta.

The knowledge of anatomic variants also helps in successful accomplishment of surgical interventions such as lymphadenectomy around the hepato-spleno-mesenteric trunk, aortic replacement with reimplantation of the trunk, or chemoembolization of liver malignancies, all of which can potentially create significant morbidity because of the large visceral territory supplied by a single vessel.[25]

Therefore, the knowledge of these variations is indispensable in operative and diagnostic procedures within the abdomen. Without a thorough understanding of the arterial architecture and knowledge of the variations present, surgery may entail a considerable risk leading to lethal complications.

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