CASE REPORT

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Anomalous pattern of origin of the left gastric, splenic, and common hepatic arteries arising independently from the abdominal aorta

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Abstract

The celiac trunk is the first unpaired midline branch of the abdominal aorta that usually gives rise to the left gastric artery (LGA), the common hepatic artery (CHA) and the splenic artery (SpA). Despite this classic arrangement, many variations exist. We describe an atypical case of an absent CT and anomalous origin of the LGA, CHA and the SpA from the abdominal aorta using multidetector computed tomography angiography (MDCTA) in a 72-year-old male patient. The LGA arose from the anterior wall of the AA at the level of the T12–L1 intervertebral disk [33.8 mm above the origin of the superior mesenteric artery (SMA)]. The SpA originated directly from the anterolateral wall of the AA at the junction of the upper-third and middle-third of the L1 vertebral body (24.8 mm above the origin of the SMA). The CHA branched directly from the anterior wall of the AA at the level of the middle-third of the L1 vertebral body (17 mm above the origin of the SMA). The 64-slice MDCTA system has become the primary tool for evaluation of abdominal blood vessels. It is important to be aware of such a variation as it can have a significant impact on surgical and clinical practice.

Keywords: abdominal aorta, left gastric artery, splenic artery, common hepatic artery, variations, MDCT angiography.

Introduction

The celiac trunk (CT) is the first unpaired branch of the abdominal aorta (AA). It arises just below the aortic hiatus of the diaphragm and divides into three branches: left gastric artery (LGA), common hepatic artery (CHA) and splenic artery (SpA) [1–5].

Matusz *et al.* [2] evaluated 10 750 cases from 19 studies and found that the typical three-branched CT ("complete CT") was present in 90.7% of cases; an "incomplete CT" was observed in 6.09% of cases; and an "absent CT" was noted in only 0.19% of cases. Seven studies assessing 6671 cases by anatomical dissection, imaging, corrosion as well as surgical and transplantation procedures (Table 1, a–f) revealed that an absent CT ranged from 0.1% [6] to 2% [7].

Isolated cases of an absent CT have occasionally been reported during dissection and imaging (Table 1, h–q).

Table 1 – ***Studies reporting the absence of the CT***

Studies						
	Authors	***Year***	***Method of examination***	***Sample size***	***[n]***	***Percentage***	***Country of description***
[a]	Rossi and Cova [8]	1904	Anatomical dissection	102	2	1.96%	Italy
[b]	Picquand [7]	1910	Anatomical dissection	50	1	2%	France
[c]	Vandamme and Bonte [9]	1985	Radioimagistic procedures, corrosion, and anatomical dissection	156	1	0.64%	Belgium
[d]	Jones and Hardy [10]	2001	Surgical and transplantation procedures	180	2	1.11%	Australia
[e]	López-Andújar *et al.* [11]	2007	Surgical and transplantation procedures	1081	8	0.7%	Spain
[f]	Song *et al.* [6]	2010	Radioimagistic procedures	5002	5	0.10%	Republic of Korea
[g]	Ugurel *et al.* [12]	2010	Radioimagistic procedures	100	1	1%	Turkey
				6671 cases	20		

Case reports					
Authors	*Year*	*Method of examination*	*Sample size*	*[n]*	*Country of description*
[h] Augustyniak [13]	1965	Anatomical dissection	1 case report	1	Poland
[i] Okada *et al.* [14]	1983	Anatomical dissection	1 case report	1	Japan
[j] Nishiguchi *et al.* [15]	1988	Anatomical dissection	1 case report	1	Japan
[k] Başar *et al.* [16]	1995	Radioimagistic procedures	1 case report	1	Turkey
[l] Higashi and Hirai [17]	1995	Anatomical dissection	1 case report	1	Japan
[m] Yamaki *et al.* [18]	1995	Anatomical dissection	1 case report	1	Japan
[n] Murakami *et al.* [19]	1998	Anatomical dissection	1 case report	1	Japan
[o] Armstrong and Franklin [20]	2006	Radioimagistic procedures	1 case report	1	USA
[p] Yi *et al.* [5]	2008	Anatomical dissection	1 case report	1	Japan
[q] Matusz *et al.* [2]	2012	Radioimagistic procedures	1 case report	1	Romania
[r] Present case	2014	Radioimagistic procedures	1 case report	1	Romania
			11 cases	11	

Here, we describe a rare case of an absent CT using multidetector computed tomography angiography (MDCTA). We also review the geographic distribution of the variations detailed in the literature.

Patient, Methods and Results

A 72-year-old male patient was examined for recurrent epigastric and mesogastric pain of two-year duration and renovascular hypertension using MDCTA (64-slice MDCTA system; SOMATOM Sensation, Siemens Medical Solutions, Forchheim, Germany) at the Neuromed Diagnostic Imaging Centre (Timişoara, Romania). Using a dual head power injector, 140 mL of non-ionic contrast medium Iomeron 400 (Bracco Imaging, Milano, Italy) was injected from an 18-gauge cannula at a rate of 4 mL/s through the antecubital vein. Imaging was performed with a delay of 27 s after the start of contrast injection, with the following parameters: tube voltage 120 kV; effective 110 mAs; rotation time 0.33 s; acquisition 64×0.6 mm; slice collimation 0.6 mm; slice width 0.6 mm; feed/rotation 15.4 mm; pitch factor 0.8; increment 1.4 mm; kernel B25f; $CTDI_{vol}$ 8.41 mGy. MDCT angiographic data were acquired in the craniocaudal direction from the dome of the diaphragm to the feet (scan length 1534 mm; scan time 29.83 s). The reconstructed image data sets were transferred to an offline workstation (Syngo MultiModality Workplace) for post-processing. The images were analyzed using a 3D task card; performing 3D Maximum Intensity Projection (MIP) reconstruction; and in-space task card for 3D Volume Rendering Technique (VRT) reconstructions.

Imaging revealed that the CT was absent and that the LGA, SpA, CHA and superior mesenteric artery (SMA) arose independently from the AA. At the level of the anterior aspect of the AA between the origin of the CHA and SMA, an atheromatous plaque was seen partially occluding the origin of the two arteries (CHA, 40%; SMA, 55%). Also, the post-ostial part of the right renal artery showed a 75% stenosis of the endoluminal surface.

In this case (Figure 1A), the AA followed a fundamentally normal course in front of the vertebral bodies (T12–L4). The SMA arose from the anterolateral wall of the AA at the level of the L1–L2 intervertebral disk. The LGA arose directly from the anterior wall of the AA at the level of the T12–L1 intervertebral disk, 33.8 mm above the origin of the SMA. It ran upwards in front of the AA and gave rise to esophageal branches. An additional left hepatic artery arose from the LGA. The SpA arose directly from the anterolateral wall of the AA at the upper-third of the L1 vertebral body, 24.8 mm above the origin of the SMA. It followed a tortuous path to the left of the splenic hilum with a splenic arterial index of 2.03. The CHA arose directly from the anterior wall of the AA at the level of the middle-third of the L1 vertebral body, 17 mm above the origin of the SMA. It ran upwards and towards the right before bifurcating to give rise to the gastroduodenal artery and hepatic artery proper. The left inferior phrenic artery arose from the left renal artery.

Discussion

Trifurcation of the CT (in the LGA, SpA and CHA) was described first by Haller [21] and is known as "tripus Halleri". The first case of an absent CT was described in a report by Geoffroy Saint-Hilaire in 1832 [14]. Variations in the branching patterns of the CT system and SMA have led to numerous classifications. In 1917, Lipshutz [22] described four types of CT branching patterns including: (*i*) hepatogastrosplenic (celiac) trunk (75%); (*ii*) hepatosplenic trunk (15%); (*iii*) hepatogastric trunk (6%); and (iv) gastrosplenic trunk (4%). In 1928, Adachi [23] described and classified the branching patterns of the CT and SMA into six types (with 28 forms): (*i*) CT (86%), (*ii*) hepatosplenic trunk (8%); (*iii*) hepatosplenomesenteric trunk (1%); (*iv*) celiacomesenteric trunk (1.5%); (*v*) hepatomesenteric trunk (0.5%); and (*vi*) gastrosplenic trunk (3%). Based on the embryological theory of Tandler [24], Morita (1935) [25] analyzed the various arrangements of the origin of the CT branches and SMA and described the first classification system that included an absent CT. Morita [25] proposed five types for the CT and four types (with 10 forms) for the celiacomesenteric trunk. For the CT, Morita's classification was: (*i*) CT; (*ii*) hepatosplenic trunk; (*iii*) gastrosplenic trunk; (*iv*) hepatogastric trunk; and (*v*) absent CT.

According to Tandler [24], during fetal development, the roots of the ventral segmental arteries are united by a "longitudinal anastomosis". Depending on the extent of the resorption/retention of the different parts of the longitudinal anastomosis and ventral segmental roots, several anatomical variants of the unpaired arteries of the AA develop. With an absent CT, the longitudinal anastomoses regress completely however, the roots of the ventral segmental arteries do not regress. The 10th

primitive roots of the ventral segmental artery become the LGA; the 11th becomes the SpA; the 12th becomes the CHA; and the 13th and 19th become the SMA and inferior mesenteric artery (IMA) [26], respectively with separate origins from the AA.

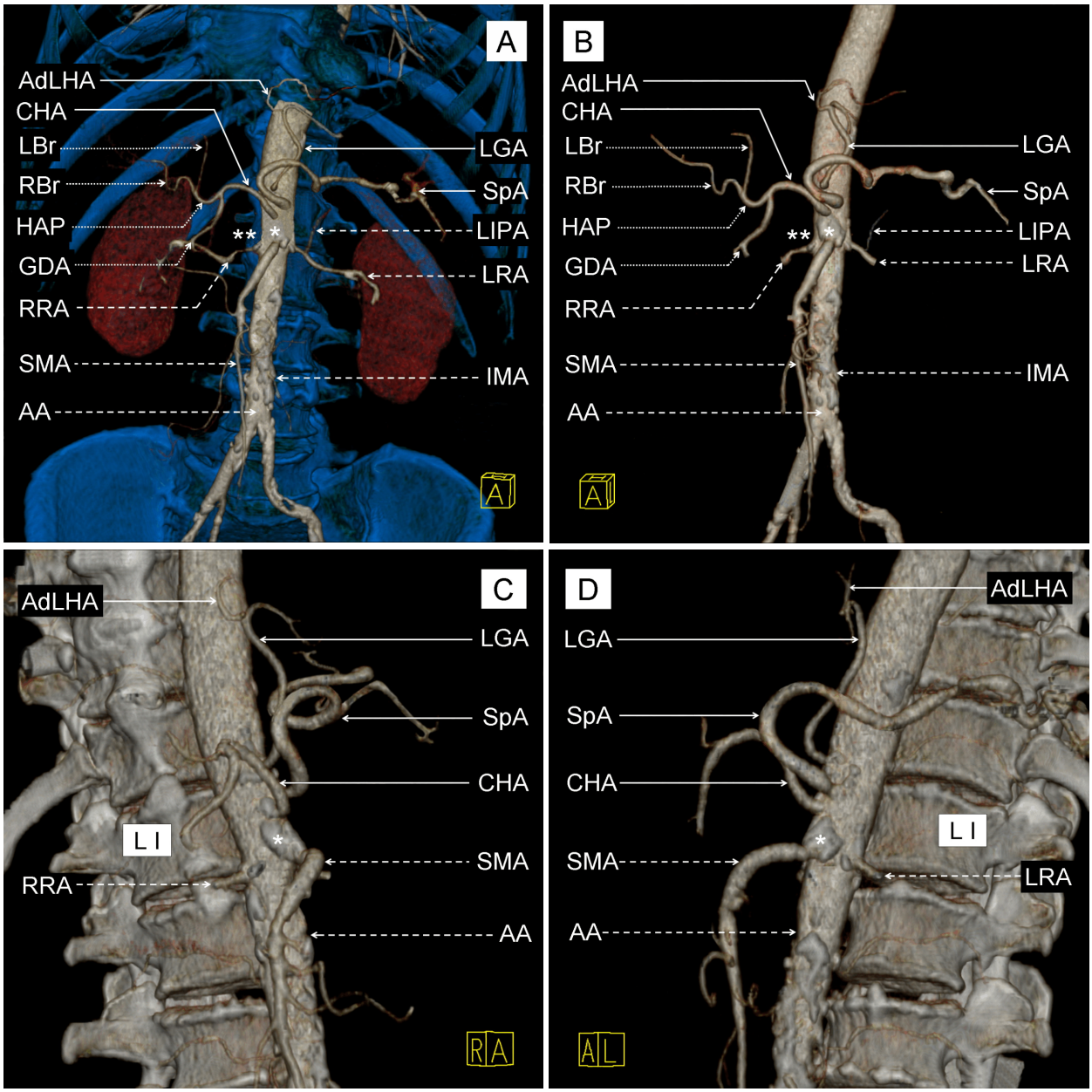

Figure 1 – ***MDCT angiography of the abdominal aorta. Rendered 3D images show the unpaired arteries originating from the abdominal aorta. (A) The relationship of the kidneys and renal arteries to the axial skeletal. (B) The spatial distribution of the unpaired arteries originating from abdominal aorta after subtraction of the osteoarticular structures. (C) The relationship of the unpaired arteries from the abdominal aorta with the thoraco-lumbar vertebral bodies from a right anterolateral view. (D) The relationship of the unpaired arteries from the abdominal aorta with the thoraco-lumbar vertebral bodies from a left anterolateral view. AdLHA: Additional left hepatic artery; CHA: Common hepatic artery; LBr: Left branch; RBr: Right branch; HAP: Hepatic artery proper; GDA: Gastroduodenal artery; RRA: Right renal artery; SMA: Superior mesenteric artery; AA: Abdominal aorta; LGA: Left gastric artery; SpA: Splenic artery; LIPA: Left inferior phrenic artery; LRA: Left renal artery; IMA: Inferior mesenteric artery; LI: First lumbar vertebral body. *Atheromatous plaque found at the anterior aspect of the abdominal aorta between the origin of the CHA and SMA with partial occlusion at the origin of the common hepatic artery and superior mesenteric artery. **Stenosis of the endoluminal surface of the post-ostial part of the right renal artery.***

In rare cases, an absent CT is associated with additional vascular variations. Our case had an additional left hepatic artery arising from the LGA. This condition was reported in the studies of Yamaki *et al.* [18] and Murakami *et al.* [19]. Matusz *et al.* [2] revealed a case of an absent CT in association with a right inferior phrenic artery originating from the left gastric artery and the presence of an additional right renal artery. Analyses of the literature (6671 cases) reveals seven studies with 20 cases exhibiting an absent CT, as well as 10 case reports with single cases of an absent CT (Table 1).

Analyses of two anatomical studies (152 cases) [7, 8] revealed the absence of the CT in 1.97% of cases. In another two studies, which evaluated 1261 cases [10, 11]

for surgical and transplantation procedures, the CT was absent in 0.79% (10) cases. Vandamme and Bonte [9] studied 156 cases (combined procedures: arteriography, corrosion, and dissection) and described the absence of the CT in 0.64% (10) cases. Analyses of two imaging studies (5102 cases) [6, 12] revealed the absence of the CT in 0.12% of cases (Table 1). From a series of case reports from 1965 to 1988, absent CT was more common in Asian populations particularly the Japanese population. Of the 31 total cases (30 reported cases and the case described here) of an absent CT reported 41.94% (13) cases were Asian; and 48.30% (15) cases were European. There was a much lower prevalence in Australia and the USA (Table 2).

Table 2 – ***The geographic distribution of the reported cases of an absent CT***

	Continent														
	Total			***Asia***			***Australia***			***Europe***			***North America***		
	T	*S*	*CR*	*T*	*S*	*CR*	*T*	*S*	*CR*	*T*	*S*	*CR*	*T*	*S*	*CR*
Anatomical dissection	10 (32.26%)	3 (9.68%)	7 (22.58%)	6 (19.36%)		6 (19.36%)				4 (12.9%)	3 (9.68%)	1 (3.23%)			
Radioimagistic procedures	9+1 (32.26%)	7	2+1 (9.68%)	7 (22.58%)	6 (19.36%)	1 (3.23%)				1+1 (6.45%)		1+1 (6.45%)	1 (3.23%)	1 (3.23%)	
Radioimagistic procedures, corrosion, and anatomical dissection	1 (3.22%)	1 (3.23%)								1 (3.23%)	1 (3.23%)				
Surgical and transplantation procedures	10 (32.26%)	10 (32.26%)					2 (6.45%)	2 (6.45%)		8 (25.81%)	8 (25.8%)				
Total	30+1 (100%)	21 (67.74%)	9+1 (32.26%)	13 (41.94%)	6 (19.36%)	7 (22.58%)	2 (6.45%)	2 (6.45%)		14+1 (48.39%)	12 (38.71%)	2+1 (9.68%)	1 (3.23%)	1 (3.23%)	

T – Total; S – Anatomical and clinical studies; CR – Case reports; +1 – The present case.

MDCTA (64-slice MDCT system) is a reliable and non-invasive tool for the diagnosis of normal and pathological conditions of AA branches. Unlike classical angiography, MDCTA clearly shows the degree of impairment of blood vessels as well as the relationship of blood vessels with surrounding structures and organs.

Conclusions

We reported on a very rare case of an anomalous pattern of the origin of the left gastric, splenic, and common hepatic arteries arising independently from the AA. MDCTA (64-slice MDCT system) has become the primary tool for evaluation of abdominal blood vessels. Knowledge of this anatomical variation is important for imaging as well as for clinical and surgical practice.

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