CASE REPORT

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Common hepatic artery arising from the left gastric artery: a case report using MDCT angiography and a brief review of the literature

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Abstract

We report a very rare case of a 67-year-old male with the presence of a common hepatic artery (CHA) arising from the left gastric artery (LGA) in association with a presence of a gastro-splenic trunk (GST), found incidentally on multidetector computed tomography (MDCT) angiography, used to investigate peripheral vascular disease. The GST arises from the anterior aspect of the abdominal aorta (AA), at the level of lower 1/3 of L1 vertebral body. The GST has a slightly concave trajectory to the right, and ends dividing into splenic artery (SA) and LGA. In the initial part of its trajectory, the SA it is wedged at 180°, pointing to the left, to the splenic hilum. The LGA has two different portions: the first dilated, initially oriented towards the higher, and then aligns to the infero-lateral left and gives birth to the second portion; the narrow portion, oriented initially horizontally, and then lower to the right. Dilated portion of LGA is continued with CHA. The CHA trunk is cuddling in a horizontal plane, at 180°, and is then oriented towards the fissure of the *ligamentum venosum* for entering in the liver parenchyma. At 51.7 mm from the origin, the CHA gives rise to the left hepatic artery (LHA), and after another 58 mm to the right hepatic artery (RHA), and finally continues with the gastroduodenal artery (GDA). Knowledge of this anatomical variation should be considered in planning and performing vascular surgery in the supramesocolic floor of the abdominal cavity.

Keywords: common hepatic artery, left gastric artery, gastro-splenic trunk, MDCT angiography, anatomic variants.

Introduction

Classically, the celiac trunk (CT), the first anterior branch of abdominal aorta (AA) originated from the anterior aspect of the AA, at the level of the T12 of vertebral body, have a length of 1–3 cm [1]. According with the historical description, the CT divides into: left gastric artery (LGA), common hepatic artery (CHA) and splenic artery (SA). This morphological aspect, considered as normal (modal), is only found in 52–80% of the cases [2]. Based on Tandler's hypothesis [3], Morita, in 1935 (cited by [4, 5]), classified the variational pattern of CT and celiacomesenteric trunk (CMT), and suggested five types and 15 forms (five forms for CT and 10 for CMT). Their analysis highlights five LGA's origins: (*i*) CHA originated from complete CT (hepato-gastro-splenic trunk); (*ii*) CHA originated from complete CMT (hepato-gastro-sleno-mesenteric trunk); (*iii*) CHA originated from incomplete CT (hepato-gastric trunk; hepato-splenic trunk); (*iv*) CHA originated from incomplete CMT (hepato-spleno-mesenteric trunk; hepato-gastro-mesenteric trunk; hepato-mesenteric trunk); (*v*) CHA originated from AA (gastro-spleno-mesenteric trunk; gastro-splenic trunk (GST); gastro-mesenteric trunk; spleno-mesenteric trunk; absent CT as morphological entity).

Analyzing a number of 200 cadavers, Michels, in 1966 [6], proposed an internationally recognized classification of the hepatic artery variations, and describes 10 morphological types (one modal and nine anatomical variations). By differentiating the aberrant hepatic arteries in accessories and replaced, Michels' classification is much more complete and more surgically useful than other proposed classifications [7]. In the Michels' classification [6], the most common variations are represented by: replaced right hepatic artery (RHA) originated from superior mesenteric artery (SMA) (11% of cases), and replaced left hepatic artery (LHA) originated from LGA (10% of cases). While CHA originating from the SMA is present in 4.5% of cases, CHA originating from LGA has the smallest frequency of the 10 morphological types described by Michels (0.5% of cases). Records of 1000 patients who underwent liver harvesting for orthotopic transplantation, Hiatt *et al.* [8] reduces the number of morphological types to six (associating in the same type the accessory and replaced hepatic artery of the same origin). CHA originating from SMA represent 1.5% of cases (Type 5), and CHA originating from AA represent 0.2% of cases (Type 6). In the classification of Hiatt *et al.* [8] is not present CHA originating from LGA. The first description of a replaced CHA originated from LGA was the one described by Adachi, in 1928 [9]. Since then, 21 cases have been described in five large series of cases (26 279 cases; 0.08% of cases) [6, 10–13], and four case reports [2, 14–16] with six cases.

Aim

The aim of this study is to document an unusual case of a CHA arising from LGA by multidetector computed

tomography (MDCT) angiography, and to document anatomical-surgical literature on this extremely rare anatomical variation.

Case presentation

The authors report a case of a 67-year-old male patient with a history of vascular disease of the AA and lower limbs. MDCT angiography examination (64-slice MDCT system; SOMATOM Sensation, Siemens Medical Solutions, Forchheim, Germany), highlights in association with the vascular lesions of the AA and lower limbs, the presence of a CHA arising from LHA (Figure 1, A and B) in association with a GST. The GST arises from the anterior aspect of the AA at the level of lower 1/3 of L1 vertebral body. With an endoluminal diameter at origin of 7.7 mm, and a length of 25.1 mm, the GST has a slightly concave trajectory to the right, and ends dividing into a bifurcation in SA and LGA. The SA with an endoluminal diameter at origin of 5.4 mm, have a length of 121.3 mm. In the initial part of its trajectory, it is wedged at 180°, pointing to the left, to the splenic hilum, with an italic *S*, being the satellite of the spleen vein tract. The LGA has two different portions: the first dilated, with a diameter of 5.1 mm at origin and a length of 33.1 mm, is initially oriented towards the higher, and then aligns to the infero-lateral left and gives birth to the second portion; the narrow portion, that have at origin a diameter of 1.5 mm, which is orientated initially horizontally, and then lower to the right (Figure 2).

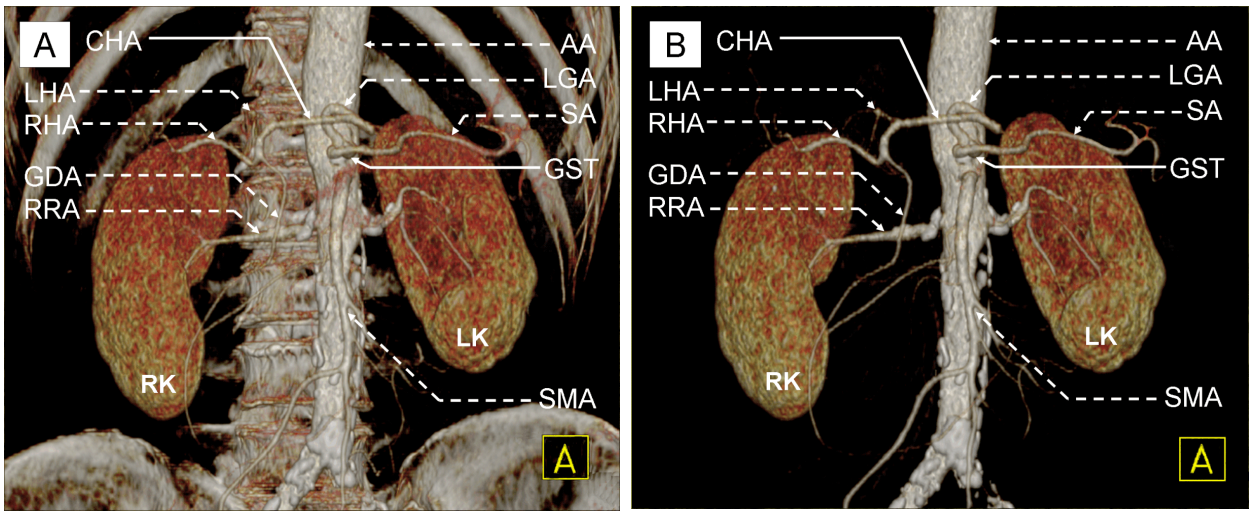

Figure 1 – ***MDCT angiography with 3D reconstruction of the AA, GST, SMA and CHA arising from LGA – coronal aspect: (A) VRT image with the* in situ *vertebral column; (B) VRT image after subtraction of the vertebral column. MDCT: Multidetector computed tomography; 3D: Three-dimensional; AA: Abdominal aorta; GST: Gastro-splenic trunk; SMA: Superior mesenteric artery; CHA: Common hepatic artery; LGA: Left gastric artery; VRT: Volume rendering technique; GDA: Gastroduodenal artery; SA: Splenic artery; LHA: Left hepatic artery; RHA: Right hepatic artery; RRA: Right renal artery; RK: Right kidney; LK: Left kidney.***

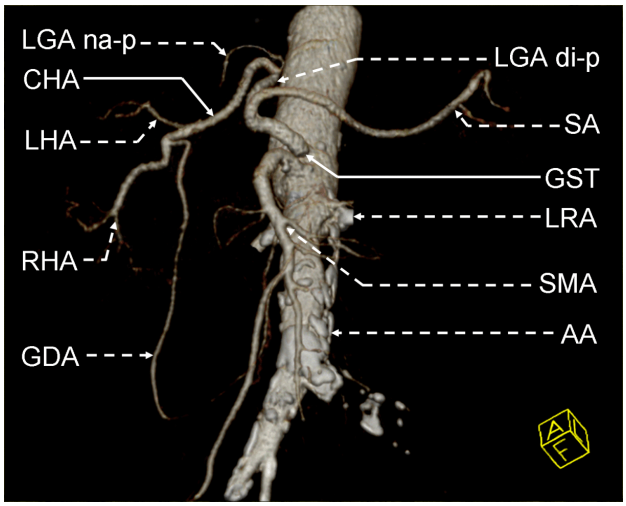

Figure 2 – ***MDCT angiography with 3D reconstruction of the AA, GST, SMA and CHA arising from LGA. VRT image after subtraction of the vertebral column and the kidneys: antero-inferior aspect. MDCT: Multidetector computed tomography; 3D: Three-dimensional; AA: Abdominal aorta; GST: Gastro-splenic trunk; SMA: Superior mesenteric artery; CHA: Common hepatic artery; LGA di-p: Left gastric artery – dilated portion; LGA na-p: Left gastric artery – narrowed portion; VRT: Volume rendering technique; SA: Splenic artery; LHA: Left hepatic artery; RHA: Right hepatic artery; GDA: Gastroduodenal artery; LRA: Left renal artery.***

Dilated portion of LGA is continued with CHA having a diameter at origin of 4 mm: in the first part of its tract, the CHA trunk is cuddling in a horizontal plane at 180° and is then oriented horizontally towards the fissure of the *ligamentum venosum* for entering in the liver parenchyma. The CHA trunk, with a total length of 109.7 mm, continues with the GDA; at origin, it has a diameter of 2.5 mm. At 51.7 mm from the origin of the LGA, the CHA gives rise to the LHA, which is distributed to the hepatic segments II–IV. After another 58 mm, the CHA gives birth to the RHA, which is distributed to the V–VIII segments, and after that continues with the GDA. The terminal portion of the CHA trunk is positioned relative to the anterior middle 1/3 of the hepatic portal vein (HPV) trunk, level at which the GDA continues with RHA. Before reaching the HPV trunk, the CHA trunk arises the LHA, which is

placed at the supra-portal level relative to the left branch of HPV and give the origin of portal segmental branches for segments II–IV. From the CHA terminal point, along with the GDA originates the RHA, which is placed infra-portal relative to the right branch of HPV, and then gives segmental portal branches for the V–VIII segments (Figure 3, A and B). SMA with an endoluminal diameter of 9.4 mm arises from the anterior aspect of the AA at the level of upper 1/3 of L2 vertebral body.

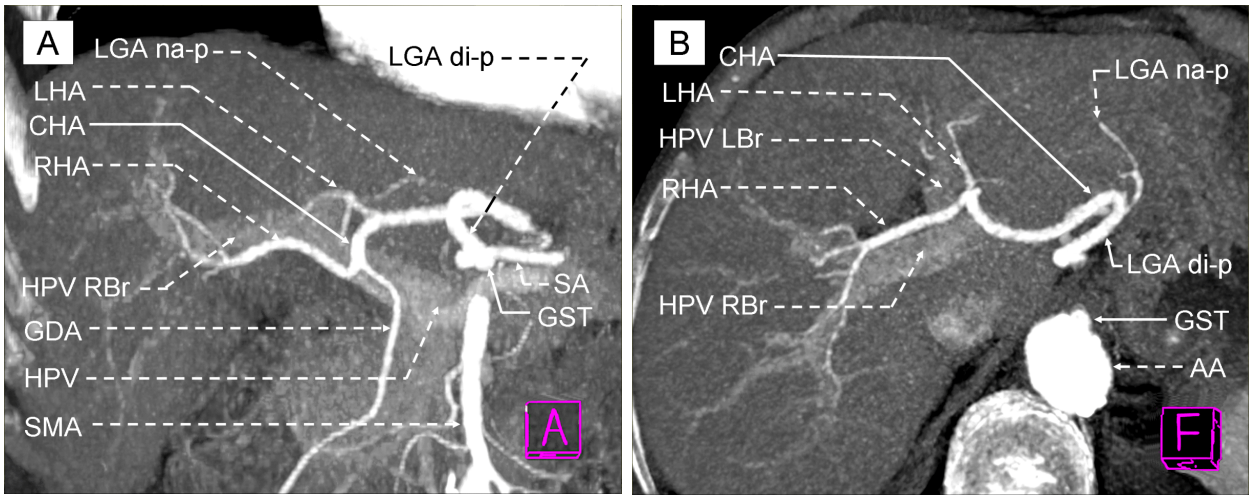

Figure 3 – ***MDCT angiography of the GST. MIP image show the GST, SMA and CHA arising from LGA: (A) Coronal image; (B) Transversal image. MDCT: Multidetector computed tomography; GST: Gastro-splenic trunk; MIP: Maximum intensity projection; SMA: Superior mesenteric artery; CHA: Common hepatic artery; LGA di-p: Left gastric artery – dilated portion; LGA na-p: Left gastric artery – narrowed portion; AA: Abdominal aorta; SA: Splenic artery; LHA: Left hepatic artery; RHA: Right hepatic artery; HPV: Hepatic portal vein; HPV RBr: Hepatic portal vein – right branch; HPV LBr: Hepatic portal vein – left branch.***

Consent

In this case report, no data were revealed regarding the patient identity. Two written informed consent were signed by the patient, first for the MDCT angiographic examination and the use of iodinated contrast agents, and the second for publication of this case report and accompanying images.

Discussions

On 4939 patients examined by using spiral computed tomography and digital subtraction angiography, Song *et al.* [12] revealed the origin of the CHA from: (*i*) CT or its equivalent (in 4763 cases; 96.44%); (*ii*) SMA (in 148 cases; 3%); (*iii*) AA – suprapancreatic preportal course (in 20 cases; 0.4%); (*iv*) LGA (in eight cases; 0.16%). Of the eight cases where CHA originates from LGA, there are present: (*i*) seven cases of hepato-gastro-splenic trunk; (*ii*) one case of hepato-gastric trunk. On 20 634 cases from 38 studies (Table 1), the overall analysis of the 10 morphological types described in the Michels classification [6] the modal type (Type I) is present in 80.57% of cases (with variations between 50.7% [25] and 81.56% of cases [11]; CHA originated from SMA (Type IX) in 1.44% of cases (with variations between 0% [24, 29] and 4.5% of cases [6]); CHA originated from LGA (Type X) in 0.03% of cases (with variations between 0% [14, 17–31] and 0.5% [6]).

The first case of CHA arising from LGA was reported by Adachi [9] from a series of 252 cases of anatomic dissections. Designated it as "Type 6, group 26" in their classification of the CT variations, the case presents a GST, in association with the presence of a CHA arising from LGA; CHA has a dominant aspect and gives rise separately to the LHA and RHA, and the GDA continues to path the CHA trunk. In 1961, Rigaud *et al.* [14] reported the second case. The third case is included in Michels' 200 anatomical dissection statistics [6] and cataloged as Type X (0.5% of cases). The fourth case belongs to Gruttadauria *et al.* [10], in a series of 701 cases of liver transplantation, case in which the RHA and LHA originated in the LGA. In one case of cadaveric liver donor, Uva *et al.* [2] describes the fifth case with a CHA that arose from the LGA, anatomical variation confirmed with imaging procedures. Okada *et al.* [15] describe by radiological procedures the following three cases (from six to eight) of CHA arose from the LGA. Song *et al.* [12], analyzing the origin of CHA variations in 4939 patients by using spiral computed tomography and digital subtraction angiography, reveal eight (0.16%) cases with CHA arising from LHA. Saba & Mallarini [13], on 1629 patients examined with MDCT angiography, highlights five cases of CHA arising from LGA. Noussios *et al.* [11], reviewing 18 810 cases from 20 studies, highlights five cases of CHA arising from LGA (0.03% of cases). Choi & Jeon [16] meet a CHA case arising from LGA to a patient with advanced gastric cancer, where it was practiced subtotal gastrectomy with D2 lymph node dissection; is the 27th case described.

According to our knowledge, the case presented is the 28th case in which the CHA arises from LGA. Our case incidentally revealed during an MDCT angiography examination to indicate vascular damage of AA and lower limbs is similar to the case described by Adachi [9] and the first of three cases presented by Okada *et al.* [15]; LHA and RHA arise from the convexity of the CHA trunk, and become the satellite of the left and right branches of HPV. As in the first case described by Okada *et al.* [15], the GST and the first part of the CHA have a particularly sinuous trajectory in front of the AA.

Table 1 – ***Incidence of hepatic artery variation according to Michels' classification as reported in large case series, using various procedures***

Michels Type			*I*	*II–VIII*	*IX*	*X*	*Other***
Authors	**Year**	**Number**	*[%]*	*[%]*	*[%]*	*[%]*	*[%]*
Michels [6]	1966	200	55	40	4.5	**0.5**	0
Suzuki *et al.* [17]	1971	200	70.5	20	3	**0**	6.5
Daly *et al.* [18]	1984	200	76	16	2	**0**	6
Rigaud *et al.* [14]	1961	216	75.5	23.1	1.4	**0**	0
Chen *et al.* [19]	2009	381	80.3	17	1.6	**0**	1.1
De Santis *et al.* [20]	2000	150	62	19.3	4	**0**	14.7
Covey *et al.* [21]	2002	600	61.3	29.2	2	**0**	7.5
Stemmler *et al.* [22]	2004	63	80.9	17.5	1.6	**0**	0
Koops *et al.* [23]	2004	604	79.1	16.3	2.8	**0**	1.8
Coşkun *et al.* [24]	2005	48	54.1	29.3	0	**0**	16.6
Winston *et al.* [25]	2007	371	**50.7**	35.2	1.6	**0**	12.5
Iezzi *et al.* [26]	2008	524	72.1	15.6	3.6	**0**	8.7
De Cecco *et al.* [27]	2009	250	66	28.7	2	**0**	3.3
Ugurel *et al.* [28]	2010	100	52	42	2	**0**	4
El-Badrawy *et al.* [29]	2011	67	64.2	32.8	0	**0**	3
Saba & Mallarini [13]	2011	1629	61.4	35.6	1.6	**0.3**	1.1
Löschner *et al.* [30]	2015	1297	72.2	23.8	2	**0**	2
Osman & Abdrabou [31]	2016	1285	72.4	25.2	2.3	**0**	0.1
Noussios *et al.** [11]	2017	18 810	**81.56**	12.94	1.3	**0.03**	4.17
Total	*Number*	**20 634**	16 624	2871	298	**7**	835
	[%]	**100**	**80.57**	**13.91**	**1.44**	**0.03**	**4.05**

*Reviewing 20 studies in the literature; **"Not otherwise described" in the literature.

By translating the origin of CHA to the LGA level, and by the presence of GST, these takes over the entire vasculature of organs in the supramesocolic floor of the abdominal cavity. The MDCT angiography shows high sensitivity in the diagnosis of abdominal vascular anatomical variations [32, 33].

Conclusions

The authors presented in this paper an extremely rare case in which the CHA arises from LGA, in presence of a GST, highlighted by MDCT angiography. The LGA has two distinct portions: (*i*) first dilated, and that continues with CHA trunk; (*ii*) the second, narrowed. Knowing this type of anatomical variation is especially important for both anatomical and medico-surgical practice.

Conflict of interests

The authors declare that they have no conflict of interests.

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