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The Accessory Left Hepatic Artery (Michels Class V): a Case Report

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ABSTRACT

Introduction: anatomical variations, particularly vascular variations, are common and their surgical implications are extremely relevant, especially in the event of trauma. The abdomen concentrates a high number of vessels, justifiable by the extension of this segment and its structural complexities, which are subject to significant variations in number, position and/or course and, in most cases, rare formations. This work describes an unusual left hepatic arterial branch.

Material and Methods: specimen from the collection of the Federal University of Juiz de Fora, Governador Valadares campus, Brazil, dissected by the Human Anatomy academic league.

Results: dissection of the posterior limit of the omental pouch at the level of the gastropancreatic fold revealed a prominent accessory branch of the left hepatic artery (LHAa) originating from the left gastric artery (LGA), a significant anatomical and medical condition and classified as Michels V.

Conclusion: the knowledge of this rare variation has a particularly important anatomical and clinical/surgical significance because of the risks in gastrectomy procedures, liver transplantation and in vascular traumas involving the hepatic vessels.

Keywords: Hepatic vasculature; Aberrant left hepatic artery; Anatomical variations; Hepatic artery variations.

Introduction

Anatomical variations of the hepatic vessels may be the result of one or more persistences of the fetal vascular pattern[1,2]. The repercussions to these vascular variations reside primarily in surgical procedures, considering that the risks are significant and maximized in trauma emergencies. In pancreatoduodenectomies, which for its high structural complexities, including the vascular ones, inadvertent surgical injuries are current due to the possibilities of hepatic vascular variations[3]. Hanif *et al.*[4] and Anwar *et al.*[5] asserted that the hepatic vascular pattern is variable and the understanding of these variants is crucial in the prevention of transoperative injuries and in decisions regarding the type of surgical approach[6]. Thus, the exact preoperative prevision of liver vasculature, of the branches of the celiac trunk and its possible variants are fundamental for a spectrum of medical interventions that range from hepatobiliary, pancreatic, gastric resections to liver transplantations[7,8]. Fouzas *et al.*[9] in a retrospective study of abdominal vessels using computed tomography (CT) in 1000 patients reported 35.6% of hepatic vascular variations. Karakoyun *et al.*[10] reported, in 409 surgical patients, 117 (28.6%) with variable presentations of the hepatic arteries, with the left hepatic artery (LHA) being the most prevalent in their findings. Cirocchi *et al.*[11], in an extensive review work in 57 studies, showed the general prevalence of aberrant LHA in 13.52% of the studied specimens. Michels[12] proposed, after an important study in 200 cadavers along 20 years of studies, a very useful and detailed classification (in ten types) of the origins of the hepatic vessels, considering, in this normatization, the replacement vessels and accessories. Hiatt *et al.*[13] proposed a less extensive classification (6 types) also considering the origins of the vessels and their accessory or substitutive conditions from a study with 1000 cadavers. Both authors worked on the pre-hilar aspects of liver vessels in their respective classifications. However, there are significant variations that were not included in the traditional classifications of Michels[12] and Hiatt *et al.*[13] and that are fundamental in surgeries[8]. Zaki *et al.*[14] in 500 patients reported 73.8% (369 specimens) of their findings as type I of the Michels classification[12], while variations were detected in 26.2% (131 specimens), with 5 individuals with variant type V formation (1%

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of the cases). In relation to the classification of Hiatt *et al.*[13], type II (origin of LHA from LGA) occurred in 41 organs (8.2%). The percentage difference between the two classifications, in this study, resides in the fact that in Michel's classification[12] type V is considered only accessory branches of the LHA, because in type II, of the same author, it is the one related to the substitute branches. In Hiatt *et al.*[13], type II includes both accessory and substitute branches of LHA associated with AGE. Consequently, the percentage difference when the two classifications are contrasted. Yan *et al.*[8] proposed an interesting classification, denominated CRL, based on the origins of the hepatic vessels and their three-dimensional vascularities measured by three-phase computed tomography (CT), comprehending variations not previously foreseen in the traditional classifications and being very useful in liver surgical planning. In relation to intrahepatic vascular distribution Garg *et al.*[15] introduced an equally important proposal for liver resection procedures, but considering the distal distributions of the hepatic vessels - the second and third orders ramifications.

Case Report

This work results from the routine of oriented dissections in practical sessions offered to students who are members of the Human Anatomy Academic League at the Federal University of Juiz de Fora / Governador Valadares (UFJF-GV). The dissected specimen containing the accessory branch of the left hepatic artery (Michel's class V) is from a cadaver male; mesomorph; declared black ethnicity (in the obituary) and of unknown age. The official registers, maintained by the Anatomy Laboratory, did not indicate the cause of death of this individual. The specimen (cadaver) had been fixed in 10% formaldehyde and in the absence of angiography techniques. Dissections did not reveal surgical procedures and/or abdominal trauma in the supramesocolic floor (space).

In the dissection of the omental pouch, at the level of its vestibule, we noted, as soon as the gastropancreatic fold was dissected, along its complete length, since the celiac trunk, a detachable volumous branch originating from the superior portion of the left gastric artery (LGA). This occurrence of its at the fundus of the superior recess of the omental pouch, at the transition point of the hepatogastric ligament with the posterior lamina of the coronary ligament (figure 1). The variant artery (the accessory branch of the LHA, 4.2 cm in length) was insinuated between the caudate lobe (the old Spiegel's lobe), quadrate and left, in direction of the hilum of the liver (figure 2). The

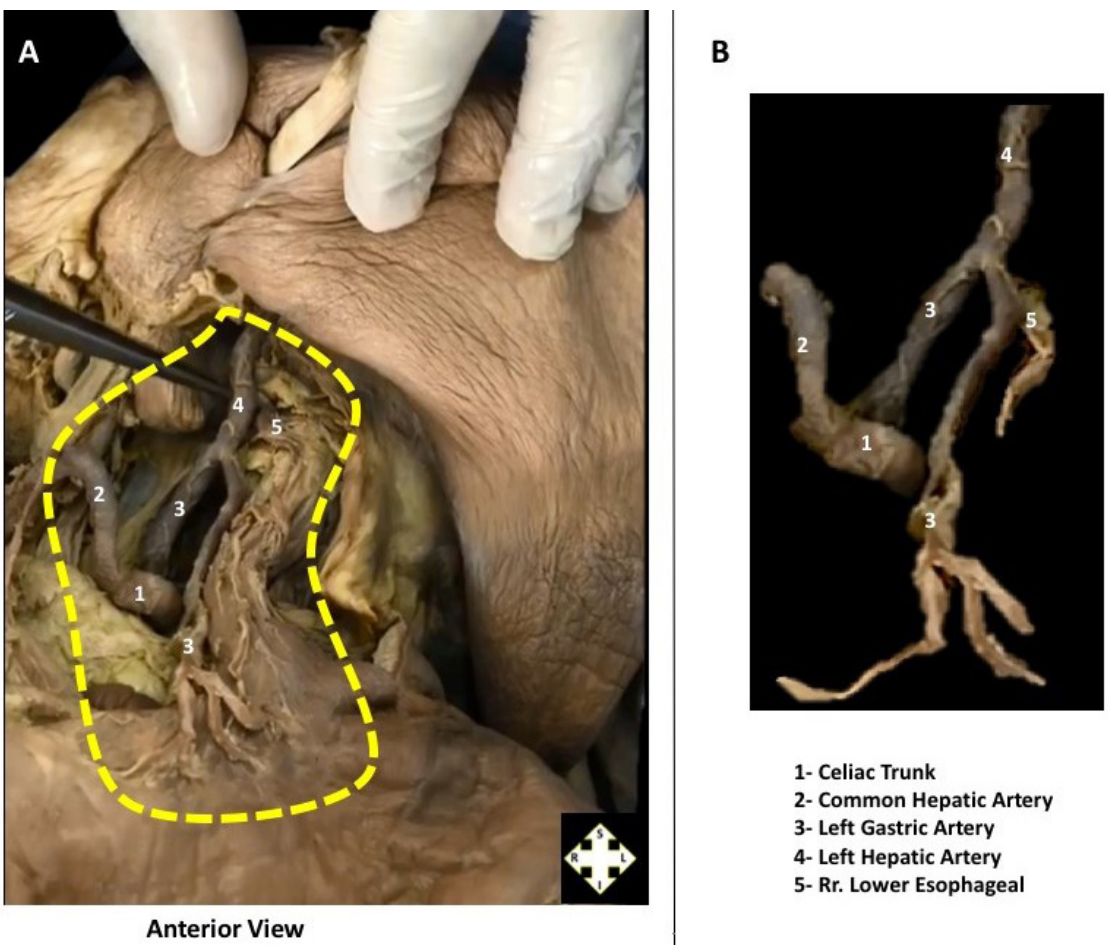

Figure 1. Vascular exposures and characterizations. In evidence the accessory left hepatic artery (4) from the left gastric artery (3).

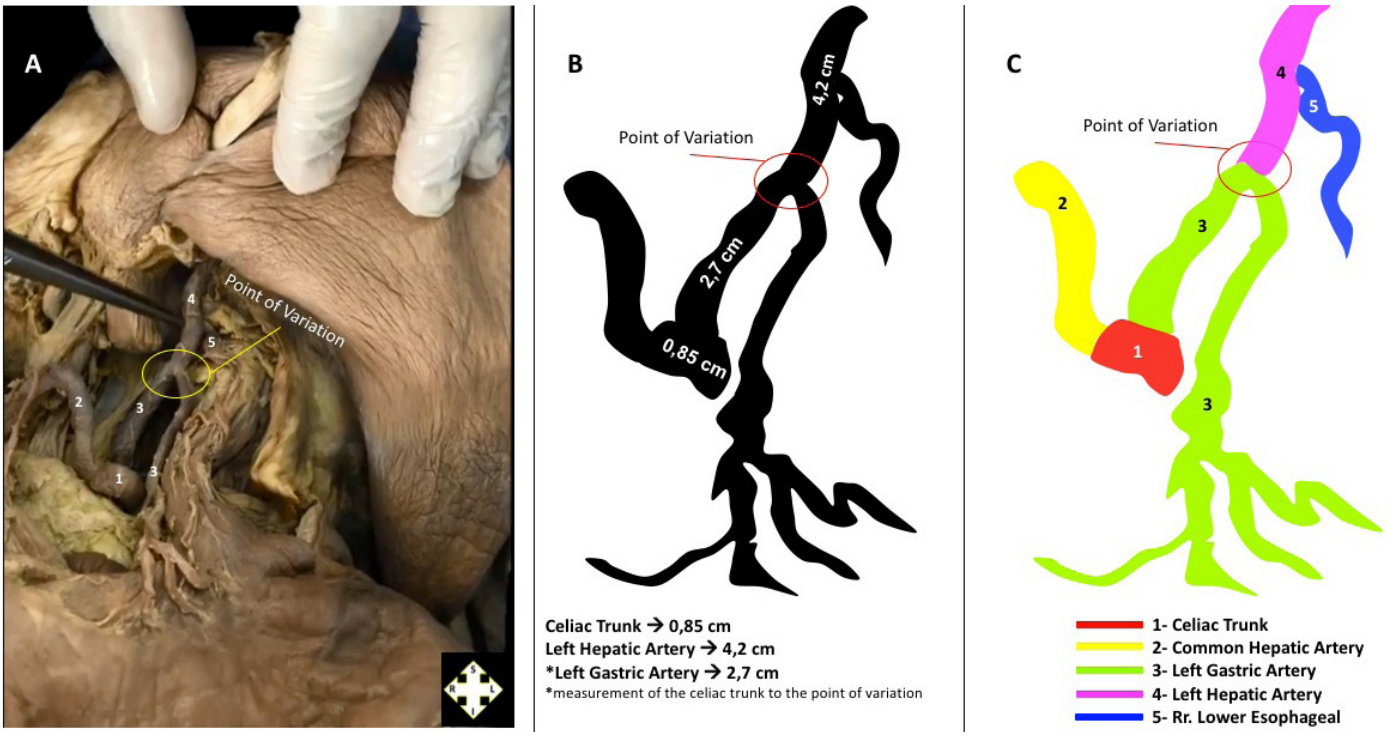

Figure 2. Anthropometric information. Partial length of the left gastric artery up to the "variation point" (2.7 cm) and the long length and significant caliber of the accessory left hepatic artery (4.2 cm) in its extrahepatic course.

variant arterial disposition accentuated the projection of the papillary process of the caudate lobe, detaching it from the limits of the transverse fissure of the liver. In addition, by proximity, there was the formation and emission of an inferior esophageal branch from the left accessory hepatic artery, which is commonly formed from the left gastric and left inferior phrenic arteries. The inferior phrenic arteries (right and left) emerged directly from a short trunk of the aorta, near the right diaphragmatic pillar, soon after the aortic hiatus. The celiac trunk showed in the classic pattern of arterial distribution with 0.85 cm in length until the formation of the left gastric Artery (Figure 2), 0.65 cm of the superior mesenteric artery and 0.50 cm of distance from the central portion of the border of the median arched ligament (the aortic hiatus). In these conditions, it was conjectured that it was an accessory or additional branch and not a substitute for the left hepatic artery (LHA), and the classifications of the three main references of normatizations for the hepatic vessels were adopted. Thus, according to the classification proposed by Michels[12], the finding was categorized as type V - accessory branch of the LHA from LGA. And as for the classification of Hiatt *et al.*[13], the finding was classified as type II, from these authors. In the recent proposal of Yan *et al.*[8], our finding was classified as type 5I (CRLal), by the CRL system.

Discussion

The presence of an accessory left hepatic artery is a variation by persistence, after fetal development, of one of the embryonic hepatic arteries - the embryonic left hepatic artery[2,16,17]. Wang and Fröber[18] consider a hypothesis of phylogenetic order, possibly atavistic, that justifies these arterial persistences. Cirocchi *et al.*[11], in an extensive systematic review, with 19,284 specimens, of which 65.35% were obtained from works that used the imaging media; 26.62% of surgical cases and 8.03% of cadaveric dissections, noted a general incidence of 13.52% of accessory left hepatic arterial formation (LHAa). However, the authors asseverate that many of the studies (34.25% of them) did not distinguish between an accessory or substitute left hepatic artery in their descriptions, which even has differences in classifications, such as that of Michels [12] and impact on decisions of surgical procedures and/or their results. Fouzas *et al.*[9] in a study with vascular registries of 116 transplanted livers, from 2013 to 2017, reported the occurrence of accessory and substitute vascular variations of LHA in 15.52% of the transplants (18 specimens), in addition to 14.66% of occurrences of variations related to the right hepatic artery. Thus, in twelve of the transplants (10.34%) the aberrant left hepatic artery emerged isolated from the left gastric artery, and in 10 of these it was the accessory type in 8.62% of the transplants and in the remaining two it was the substituted type (1.72%). Michels[12] reports that the occurrence of normal liver pattern occurred in 55% of cadavers, while in Hiatt *et al.*[13] the authors indicated 75.7% of "normality" in the arterial pattern of the liver, results close to those found by Zaki *et al.*[14] who through multidetector computed tomography scans in 500 patients of Egyptian origin noted normality in the arterial pattern in 73.8% of them and

only 1% of Michel's type V. Findings similar to the normality pattern of the results of Çankaya *et al.*[6] in which the authors report, from retrospective studies of three-phase CT scans of the livers of 180 donators, 71% of the results classified in Michel's class I, 5.6% in the type V of this same classification (accessory left hepatic Artery) and 6.7% in type II (replacement branch of the left hepatic artery). Anwar *et al.*[5] from an extensive study with 500 people submitted to angiographies, for various medical reasons, by multidetector computed tomography of the abdominal region, noted, as regards the hepatic vascular patterns, the occurrence of 61.2% of patients classified as type I (vascular normality). However, of the most common variations, in a higher incidence than other works, was the origin, by replacement, of the left hepatic artery by a branch from the left gastric artery in 11.4% (Michel's class II). The findings of class V, according to the occurrence of our study, as an accessory branch of the left gastric artery, the authors indicated only in 4.4% of the investigated ones. Miyaki [17] reports, in a study of hepatic dissection in sixty fetus, with more than 5 months of development, the high incidence of these arterial variations - 30% involving one to two aberrant arteries. Multiple accessory or replacement formations can occur and are a challenge to surgery, as is the description of a rare condition made by Yaseen *et al.*[2] in which the authors identified in a unique specimen 5 liver branches between left and right arteries, including a very rare accessory right liver branch from the gastroduodenal artery (GDA). In a description by Wang and Fröber[18] the authors reported a laboratory finding of 3 variant extrahepatic arterial branches in a unique specimen and with the occurrence of Michel's class V. Fouzas *et al.*[9] indicate the occurrence of 72.41% of the pattern of hepatic arterial distribution and attribute the high incidence of variations related to the right hepatic artery (of the accessory and replacement types), in comparison to consecrated studies, with reasons of genetic order or genetic predisposition, once all the organs were registered as of Greek nationality donors. The study of intrahepatic vascular branching, conducted on 100 cadaver livers by Garg *et al.*[15] revealed a very high disagreement when compared to the literature, both for LHA and RHA. Thus, the authors reported only 25% of the livers presenting in the anatomical pattern. This is of high relevance for procedures such as selective catheterization of segments of this organ. As for the origin of the LHA, the authors noted it in 3% of the LGA, as a substitute branch. Gkaragkounis *et al.*[7] in an extensive retrospective vascular anatomical study of 1520 computed tomographies, analyzed all anatomical variations associated to the celiac trunk and its branches, those associated to the superior mesenteric artery (strictly hepatic aberrant branches) and the variations of the conventional hepatic branches. The findings were categorized in Michel's proposed classification. Thus, this study indicated 72.89% of the cases classified as Michel's class I (normal), incidence very near to the studies of Fouzas *et al.*[9], as already described, and 22.89% of variations that were classified in Michel's types from II to IX. Regarding the variations strictly related to LHA, the authors indicated 14.67% of the cases (223 specimens), so that the origin of LHA directly from LGA was observed in the majority - 12.11% (184 specimens), and in only 0.86% were indicated as Michel's V (accessory branch of LHA from LGA). Zhang *et al.*[3] retrospectively analyzed the results of 218 Chinese surgical cases of pancreatoduodenectomy of patients with and without hepatic vascular variations (identified by preoperative angiographies). The variant cases were 24.8% of the specimens, the most common being the formation of the accessory right hepatic artery (RHAa) from the superior mesenteric artery (SMA) and the data showed no significantly higher complications when these arterial vascular variants were present. In another important retrospective study of computed tomography images of 1000 Pakistani patients, conducted by Hanif *et al.*[4], the authors classified the variations of the hepatic vessels in the six types by the method of Hiatt *et al.*[13] and described the pattern (type I) in 64.4% of the findings and in 135 patients there was the variation of type II of Hiatt in which the LHA was replaced or followed as an accessory branch. Thus, the authors described that the majority of type II emerged directly from the LGA (98.5%), and this origin as an accessory branch occurred in only 11.85% (16 cases) - which corresponds to Michel's type V classification. The case described in this article (figure. 01) would fit this classification, however, without the indication, in Hiatt's normatization, between an accessory or substitute type finding. Karakoyun *et al.*[10] analyzed the hepatic vascular variations and their impacts in post-surgery. The authors identified arterial hepatic variations in 28.6% (most occurring with LHA from the LGA, in 45.3%), and in more than half of the patients (58%) reconstructions with at least two arterial anastomoses were necessary and the total incidence of thrombosis, as a complication, was of the order of 0.7%, whereas the findings of Fouzas *et al.*[9], in arterial thrombosis, were 5.17% in a series of 116 transplanted patients. Ang *et al.*[19] reviewed the surgeries of 2487 patients, from 2012 to 2016, for gastrectomy procedures, of which 17.7% (442) had variations related to the left hepatic artery. However, only 204 were included in the study, and in 131 there was a replacement formation of the left hepatic artery (64.2%) and in 73 of the patients the shape or accessory type (35.8%). However, they did not determine if the accessory types were exclusive or not of the left gastric artery. In this study, the authors claimed that the hepatic functions were not affected or there were no related

vascular disorders in cases of ligatures of the accessory left hepatic artery (type V). Vasconcelos-Filho *et al.*[20] in an extensive work of hepatic vascular pattern analysis of 340 donor files for transplantation computed 66.17% (225 cases) as type I of Hiatt (the pattern of vascular distribution), within the interval of vascular "normality". In 46 cases (13.52%) the authors classified the findings as type II (equivalent in part to Michel's type V), but without specifying whether the occurrences were of a substitute or accessory branch of the LHA. Recently, an innovative work, based on CRL classification, was proposed by Yan *et al.*[8] based on three-dimensional CT scans. The study investigates the vascular anatomical variation using three-dimensional visualization and evaluation (3DVE) to develop a new classification and nomenclature system, denominated CRL, based on parameters referring to the origins of the common hepatic arteries (CHA), right (RHA) and left (LHA) in nine types and subtypes. The origin and course of the hepatic artery are traced and analyzed. The CRL classification was validated based on external data collections from previous studies, with 99·6 to 100·0% of patients classified by the CRL system, different from traditional classifications where there are conditions of non-classifiable variations, which may negatively influence liver transplantation, arterial embolization or infusion chemotherapy for liver tumors. The case described in this article is classified in the CRL system as 5I (CRLal). As for the type variant under study (Michel's type V) we have compiled the recent works with modern detection techniques according to the table presented below: (table1).

Conclusion

The occurrences of vascular variations are the norm, especially in an extensive region and with a large number of visceras of complex structuralization, and with relative distances between them, to be irrigated and drained, as is the case of the abdominal segment. Thus, for the purpose of security and successes in resections, a detailed and deep understanding of the incidences of vascular variations is required for any surgical maneuvers and/or other procedures that demand the vascular referential.

Table 1. aLHA, accessory left hepatic artery; LGA, left gastric artery; CT, computed tomography; CTA computed tomography angiography

Article	Methodology	N	Miclel's V (LHAa from LGA)	%
Anwar *et al.* (2019)	multidetector CT	500	22	4.4
Fouzas *et al.* (2019)	surgical dissection	116	10	8.82
Garg *et al.* (2019)	cadaveric dissection	100	5	5
Gkaragkounis *et al.* (2019)	dynamic contrast-enhanced CT and CTA	1520	13	0.86
Hanif et al. (2020)	CTA	1000	16	0.16
Karakoyun *et al.* (2020) #	surgical dissection	409	53	12.9
Vasconcelos-Filho *et a*l. (2020) #	surgical dissection	340	44	12.94
Yan *et al.* (2020)	triple-phase CT	770	20	0.26
Yilmaz *et al.* (2020)	triphasic abdominal CT	180	10	5.6
Zaki e*t al.* (2019)	dynamic enhanced multidetector CT	500	5	1
Zhang *et al.* (2020)	three-dimensional multidetector CTA	218	10	4.6

includes both Michel's type II and V

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