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, these variants is crucial in the prevention of trans-operative 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 hepatobilary, pancreatic, gastric resections to liver transplantations.8,10 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. Michels12 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 Michels12 and Hiatt et al.13 and that are fundamental in surgeries. Zaki et al.14 in 500 patients reported 73.8% (369 specimens) of their findings as type I of the Michels classification, while variations were detected in 26.2% (131 specimens), with 5 individuals with variant type V formation (1%
of the cases). In relation to the classification of Hiatt et al., 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, 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., 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. 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. 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).](image-url)
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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\textsuperscript{12}, the finding was categorized as type V - accessory branch of the LHA from LGA. And as for the classification of Hiatt et al.\textsuperscript{13}, the finding was classified as type II, from these authors. In the recent proposal of Yan et al.\textsuperscript{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\textsuperscript{2,16,17}. Wang and Fröber\textsuperscript{18} consider a hypothesis of phylogenetic order, possibly atavistic, that justifies these arterial persistences. Cirocchi et al.\textsuperscript{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\textsuperscript{12} and impact on decisions of surgical procedures and/or their results. Fouzas et al.\textsuperscript{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\textsuperscript{12} reports that the occurrence of normal liver pattern occurred in 55% of cadavers, while in Hiatt et al.\textsuperscript{13} the authors indicated 75.7% of "normality" in the arterial pattern of the liver, results close to those found by Zaki et al.\textsuperscript{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\(^7\) 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\(^16\) 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 72.4% 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 livres 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.\(^3\), 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. 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. 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 996 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: (Table 1).

### 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>
<thead>
<tr>
<th>Article</th>
<th>Methodology</th>
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<td>Anwar et al. (2019)</td>
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<td>5</td>
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<td>13</td>
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<td>CTA</td>
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<td>10</td>
<td>4.6</td>
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</table>

# includes both Michel’s type II and V

### References


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