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Case Report
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An Accessory Right Hepatic Artery Arising From Superior Mesenteric Artery And Its Clinical And Surgical Significance

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ABSTRACT

Introduction: along with the celiac trunk, the superior mesenteric artery promotes most of the vascularization in the digestive system, providing nutrients and oxygen to vital organs, particularly the liver. For this reason, it is relevant for daily practice to study the anatomy of the arteries, both in their classic form and their possible variations and anatomical variations. Therefore, it is fundamental to know which clinical and surgical effects can be consequential, whatever the change, either functional or anatomic. When variations are hardly ever found, they should result in better patient care, whether in liver transplantation cases, duodenopancreatectomy, and cholecystectomy. Thus, they can assure more appropriate and targeted treatment when recognized.

Case report: the present case report describes the prevalence, clinical, and surgical importance of an aberrant branch of the superior mesenteric artery, classified by Michels as an accessory right hepatic artery, in a corpse dissection from an Anatomy Laboratory.

Conclusion: the knowledge of anatomical variations and accessory arteries is essential to prevent and avoid surgical sequelae and possible postoperative complications.

Keywords: Hepatic Artery; Mesenteric Artery, Superior; Anatomic Variation.

Introduction

The superior mesenteric artery (SMA) embryonically supplies irrigation to the midgut, originating as the third anterior branch of the abdominal aorta at the level of the lower margin of the L1 vertebra and irrigating the following structures: the duodenum, jejunum, ileum, cecum, vermiform appendix, ascending cervical and two-thirds of the transverse cervical. The pancreaticoduodenal, middle colic, right colic, ileocolic, jejunal, and ileal arteries arise directly from SMA. Although this is usually the standard anatomic position, some variations in the branches have been described in the literature[1,2]. These variations and their relationship with the adjacent structures are crucial from a historical, clinical, and surgical perspective, given the consequences and risks that the lack of knowledge of these accessory or aberrant structures may imply in possible iatrogenesis in surgical procedures[3,4,5].

A recent literature review has described that about 19% of the evaluated patients did not show any variations of the normal anatomy as previously described. Among the most common variations, it is the presence of the right branch of the right hepatic artery (RHA) arising from the SMA or the left gastric artery (LGA)[3-6,7]. An accessory artery is defined when an extra arterial branch is present and characterized as aberrant; in this case, this arterial branch is only responsible for the blood supply of a specific region. As illustrated above, anatomical variations lead to changes in surgical strategies, for instance. Therefore, a vast theoretical and practical knowledge with proper preoperative planning reflects deeply on the patients' prognosis[3,4].

Michels has identified anatomical variations from 200 dissections and proposed ten classifications covering the common hepatic artery (CHA), the proper hepatic artery (PHA), and its branches, as shown in Table 1[3]. Subsequently to Michels, Hiatt *et al.* (1994) also described vascular variations, which according to him it has been reported from 25 to 75% of 1,000 patients evaluated, as shown in Table 2[8]. This information is vital for surgeries, radiological processes, laparoscopic operations of the biliary tract; it implies the need for planning in terms of surgical conduct. In addition, it is necessary to use preoperative imaging exams to assess resection and reconstruction in liver transplantation cases, hepatic procedures, biliary, pancreatic, and duodenal regions, aiming at positive outcomes [5-8,9].

Therefore, this article aims to perform an anatomical description of an accessory artery, targeting the right hepatic lobe and arising from the SMA present in an anatomical specimen and its correlations with possible clinical and surgical implications.

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Table 1. Michels' (1966) classification.

I	Normal anatomical pattern of irrigation of the hepatic system
II	LHA accessory arising from LGA
III	RHA arising from SMA
IV	RHA arising from SMA and LHA arising from LGA
V	LHA accessory arising from LGA, both arising from SMA.
VI	RHA accessory arising from SMA
VII	RHA accessory arising from SMA, in addition to LHA arising from LGA.
VIII	Aberrant RHA and an accessory LHA combination or otherwise.
IX	Absence of hepatic CT and origin of irrigation from the SMA.
X	Absence of hepatic CT and origin of irrigation from the LGA.

Abbreviations: LHA: left hepatic artery; LGA: left gastric artery; RHA: right hepatic artery; SMA: superior mesenteric artery; CT: celiac trunk.

Table 2. Hiatt *et al.* (1994) classification.

I	Classic anatomy
II	LHA accessory or replaced arising from LGA
III	RHA accessory or replaced arising from SMA
IV	RHA and LHA arise, respectively, from SMA and LGA.
V	CHA as a branch of SMA.
VI	CHA arises directly from the aorta.

Abbreviations: LHA: left hepatic artery; LGA: left gastric artery; RHA: right hepatic artery; SMA: superior mesenteric artery; CHA: common hepatic artery.

Case Report

During a routine analysis on an anatomical specimen at Centro Universitário Barão de Mauá Anatomy Laboratory in Ribeirão Preto, São Paulo, it has observed the presence of an accessory RHA that irrigates the right hepatic lobe, as shown in figure 1A. In classical anatomy, from the PHA, the left and right hepatic branches emerge, in which they are responsible for the irrigation of the left and right hepatic lobes, respectively. In this figure from the anterior view of the abdomen, it might have noted that the presence of the accessory RHA (Mitchel type VI or Hiatt type 3 classification) originates from the SMA.

It is essential to report the retropancreatic pathway of this accessory branch[3-7]. To facilitate the understanding of the pathway of the accessory PHA, it performed an illustration as shown in Figure 1B. In Figure 2A, it is evident the presence of the Accessory PHA, Accessory Cystic Artery, Cystic Duct, Common Liver Duct, Choledoctic Duct, CHA, PHA, Gastroduodenal Artery, and Superior Mesenteric Vein. Also, it has noted the presence of an accessory artery of the cystic artery, which is generally a branch of the PHA, being in this case, a brunch of the accessory PHA[10]. Figure 2B shows an illustration of the anatomical piece to highlight the anatomical findings.

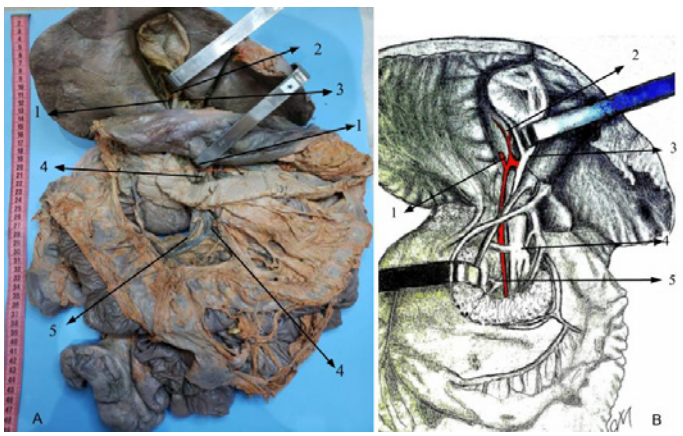

Figure 1. A. Anterior view, details of the anatomical structures present. (1) Accessory Right Hepatic Artery, (2) Accessory Cystic Artery, (3) Cystic Duct, (4) Superior Mesenteric Vein, and (5) Superior Mesenteric Artery. B. An anatomical specimen illustration. Copyright and image use.

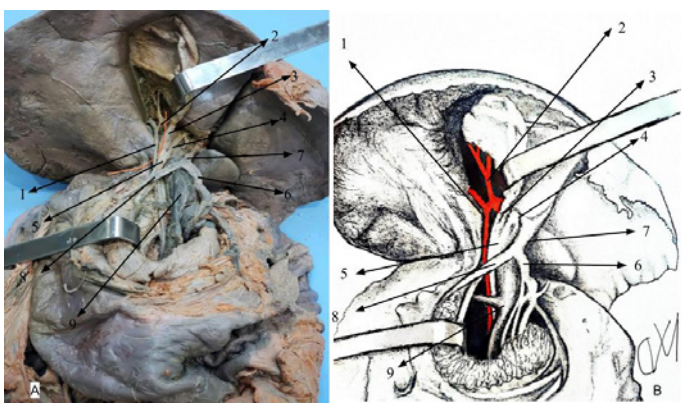

Figure 2. A. Anterior view, details of the anatomical structures present. (1) Accessory Right Hepatic Artery, (2) Accessory Cystic Artery, (3) Cystic duct, (4) Common hepatic duct, (5) Choledoc duct, (6) Common hepatic artery, (7) Own hepatic artery, (8) Gastroduodenal artery, (9) Superior mesenteric vein. B.An anatomical specimen illustration. Copyright and image use.

Discussion

The present study has observed the presence of an accessory RHA arising from the SMA. A systematic review with a meta-analysis of 78 studies has described the accessory/replacing RHA in 13.2%. In the analysis by region, the prevalence of accessory/replacing RHA was 9% in Asia, 15.5% in Europe, and 13.8% in the USA[11].

It analyzed 1,000 medical donor records for orthotopic liver transplantation in the study by Hiatt *et al.* (1994), obtaining 106 cases (10.6%) with the accessory or replaced RHA, branch of the SMA. Based on this work, it has proposed Hiatt's classification[8]. Our study has assessed the type III according to Hiatt's.

In another publication, the accessory or the aberrant RHA represented 11.9% of 604 cases evaluated in angiography exams, 20 of which were due to the accessory RHA (3.3%)[13].

A retrospective study aimed to identify the anatomical variations in the hepatic arterial system in liver transplants in 479 donors: it has observed the accessory or replaced RHA by the SMA is type III according to Michels' classifications; representing 6.05%. The accessory RHA arises from the SMA out of 0.4% (Type VI by Michels and Type III by Hyatt)[14]. In this perspective, from a liver irrigation angiographic analysis, 20 donors for liver transplants were evaluated, and only one presented the accessory RHA from the SMA[15].

It has analyzed computed tomography scans of 200 patients in the study by Balzan *et al.* (2019), and of these, about 13% showed an anatomical variation of the RHA. The replaced RHA arising from the SMA consisted of 12 cases and two cases of the accessory RHA with a similar origin, presenting its posterior orientation to the portal vein[5]. Along the same lines, a retrospective study of the database of São Vicente de Paulo hospital in 2016 analyzed 461 abdominal CT images with contrast and CT angiography involving the abdominal aorta and its branches. The accessory RHA arising from the SMA was present in 11 (2.39%)[16].

When analyzing 64 corpses, Ottone *et al.* (2016) observed 3.12% with the accessory RHA from the SMA, with a retroduodenoportal route[17]. Based on a similar study design, Sebben *et al.* (2013) noted the same anatomical variation in 10% of the studied specimens, considering the most prevalent type of variation in this study[18].

There were 263 cases of patients with periampullary tumor in the retrospective observational case study 7.2% of them had non-classical hepatic arterial anatomy, with 7 (4.63%) patients with the replaced RHA and 2 (1.32%) with the accessory RHA[19]. In Yaseen *et al.* (2019) and Hentati *et al.* (2001) case reports, anatomical variations of the hepatic arterial system described the presence of the accessory RHA arising from the SMA irrigating the right hepatic lobe, while in the study Felli *et al.* (2016), the RHA arising from the SMA crosses the RHA irrigating the left lobe of the liver[20-22].

Finally, a study carried out with patients undergoing a pancreaticoduodenectomy found that of the total of 232 cases, the hepatic arterial variation was present in 35 (15.1%). The most frequent was the presence of the accessory RHA (8.19%), followed by the aberrant RHA (5.6%), both arising from the SMA and with a parallel pathway and adjacent to the right side of the common bile duct[23]. Thus, it is possible to note that the presence of the accessory artery reported in our study is not uncommon.

Regarding the possible clinical and surgical implications, the duodenopancreatectomy (DP), for example, is the procedure performed to remove the head of the pancreas and the duodenum, as well as the choledochal duct and gallbladder, and the gastric antrum can be resected or preserved, depending on the technique used[24]. In an observational study, it has proposed to compare results after DP in patients with or without a variant hepatic artery arising from the SMA. It has described eleven patients with a hepatic artery from the SMA, two with an accessory branch of the RHA. All patients with anatomical variation who underwent the DP did not show significant changes in the margins of pancreatic resection and the incidence of postoperative complications. Consequently, the authors Molmenti, Klein, and Henry (2004) carried out a study on a careful dissection technique in DP to preserve both the distribution of classic vessels and possible abnormal vessels, both in the liver and pancreas[19]. First, it consists of the retropancreatic dissection of the superior mesenteric vessels. Then, after adequate mobilization of the vessel samples, the pancreas is divided on the head or body of the pancreas[25]. And similarly, the identification of possible anatomical variations of the hepatic artery, such as the accessory RHA, becomes essential in the preoperative course, with angiography being a fundamental tool in the resection of the pancreas head[26].

A case report has described the clinical chart of a 64-year-old patient with a liver cirrhosis history due to hepatitis C, who underwent an orthotopic transplant, a preoperative computerized topography was diagnosed afterward, with extensive portomesenteric venous thrombosis. As a result, there was a need for the portal vein arterialization from the accessory RHA arising from the SMA during the procedure, trying to increase the portal influx. Although this procedure is safe, it has been limited by using the anatomical variation, besides having regular long-term results[27].

Following the same reasoning as a rare report, in 2012, another publication reported the case of a patient with abdominal pain, jaundice, and melena, in addition to physical examination with a palpable gallbladder. The image examination of the abdomen revealed a pseudoaneurysm of the accessory RHA arising from the SMA due to large gallstones[28]. Therefore, it is evident the rare events related to this anatomical variation.

In addition, liver transplantation is a procedure, which there is a possibility of vessel damage; consequently, angiography is a crucial procedure in this surgical intervention[15]. This tool has the competence to diagnose anatomical variations in the distribution of the vessels and; therefore, according to Koops, Wojciechowski, Broering, Adam, and Krupski-Berdien (2004), it is possible to think in advance about strategies for surgery when there is the presence of accessory vessels[12]. It is relevant and evidenced in a study made by the analysis of 1145 transplants, in which it describes that in 19% (n = 222) of the procedures, there was a need for arterial reconstruction[28].

Finally, it was reported the vascular anatomy of 64 dissections in another publication, with 3.12% of them having an accessory RHA. It has been observed that the accessory and the aberrant RHA branches had a

dangerous retroduodenoportal pathway, which would imply the need to examine the posterior face of the hepatic pedicle due to the risk of injury to the hepatic vessels, mainly when cholecystectomy is performed[17]. Thus, with detailed knowledge of anatomical variations, procedures will occur successfully[14].

The regular irrigation of the liver is done by branches of the PHA, which is a branch of the CHA. Even though there are anatomical variations, such as aberrant or accessory arteries, which represent a challenge in clinical evaluation and the surgical area. In this case report, it was observed, as an example of anatomical variation, the presence of the accessory RHA arising from the SMA towards the right lobe of the liver in the anatomical specimen. Thus, knowledge of classical anatomy and its anatomical variations is essential to prevent surgical sequelae and possible postoperative complications.

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