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ANATOMIC VARIATIONS

Rare anatomic variation of the hepatic arterial blood supply: case report and literature review

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Abstract

Purpose Our aim is to present a rare case of anatomic variation of the arterial blood supply to the liver because preoperative knowledge of hepatic vascular variations is mandatory in hepatic surgery and liver transplantation.

Methods We present a case of unusual arterial blood supply to the liver, a right hepatic artery coming from the splenic artery, associated to a classical common hepatic artery and a left hepatic artery from the left gastric artery. Preoperative diagnosis was made using CT-scan and 3D reconstruction.

Results The right hepatic artery was found behind the portal vein and its diameter showed its importance in the vascularisation of the liver. To our knowledge this type of variation has only twice been described before. The accuracy of the 3D reconstruction allowed us to adopt the best surgical strategy to avoid lesions of the two accessory arteries which proved important sources of blood supply.

Conclusions Precise preoperative evaluation of liver blood supply has great importance on surgical, transplantation strategy and outcome and rare anatomic variations have to be known to avoid lesions of potentially important arteries. New techniques of 3D reconstruction can ease the preoperative recognition of such difficult anatomic variations.

Keywords Liver anatomy · Arterial supply · Anatomic variations · Liver surgery

Introduction

Michels [8], Melliere [7] and later on Hiatt [4] have shown in their studies that the arterial blood supply of the liver presents classical branching patterns in only 55% of the cases while in the rest of the 45% atypical branching variants are present. Such a large percentage of atypical arterial vascular anatomy of the liver should draw attention to the fact that intraoperative complications due to lack of knowledge of the arterial blood supply not only happen during dedicated hepato-biliary and pancreatic procedures but also during other general surgery procedures, in cases of rare anatomic variants [10]. Koops et al. [6] propose one of the most exhaustive and complex classifications of the arterial blood supply of the liver, but more recently Kobayashi et al. [5] have published another, more detailed classification based on the study of 1200 angiography cases. Even if those classifications try to describe all variations, many rare variations may exist, making it almost impossible to classify all of them into a specified pattern.

Case report

We were confronted with a case of a rare anatomical variation of the blood supply of the liver discovered during the investigations performed before a liver harvesting procedure from a deceased donor. The CT-scan performed before the harvesting procedure showed the common hepatic artery, originating from the celiac trunk, a left accessory hepatic artery originating from the left gastric artery directed to the left liver, and a right accessory hepatic artery branching out of the splenic artery, running posterior to the portal vein and supplying the right liver. A 3D reconstruction was performed by Visible Patient to better study the anatomy preoperatively (Fig. 1b).

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During back-table dissection these radiological findings were confirmed (Fig. 1a). We found an accessory right hepatic artery arising from the splenic artery 3 mm after its origin. This accessory artery originated on the inferior aspect of the splenic artery and entered the retroportal lamina, posterior the portal vein. Later on during its course, the accessory right hepatic artery passed behind the infundibulum of the gallbladder and entered the right liver lobe on the topography of segment V.

The diameter of the accessory artery was nearly 3.5 mm—two times larger than the principal right branch and we suppose that this artery presented a significant source for the arterial supply of the right liver lobe.

In this case a second anatomic variant in the form of an accessory left hepatic artery arising from left gastric artery was present, apart from the classic common hepatic artery branching from the celiac trunk.

Discussion

To our knowledge an accessory right hepatic artery arising from the splenic artery has only been described twice before in the literature. After a detailed review of the literature analysing 11,000 cases across English, French and Italian articles regarding anatomic variations of liver vascularisation, in 2016, Caruso et al. [2] report a single case of such accessory right hepatic artery arising from the splenic artery. Later on, in 2017 Al Zahrani et al. [1] report another case of the same anatomic variant in a patient presenting with a hepatocellular carcinoma exclusively supplied by this accessory artery.

This variant is not described in any of the classifications describing anatomic variants of the hepatic blood supply [4, 8, 9]. Despite the fact that the anatomic variant we have found and describe herein appears to be rare, we feel it is important to describe such variants especially for more

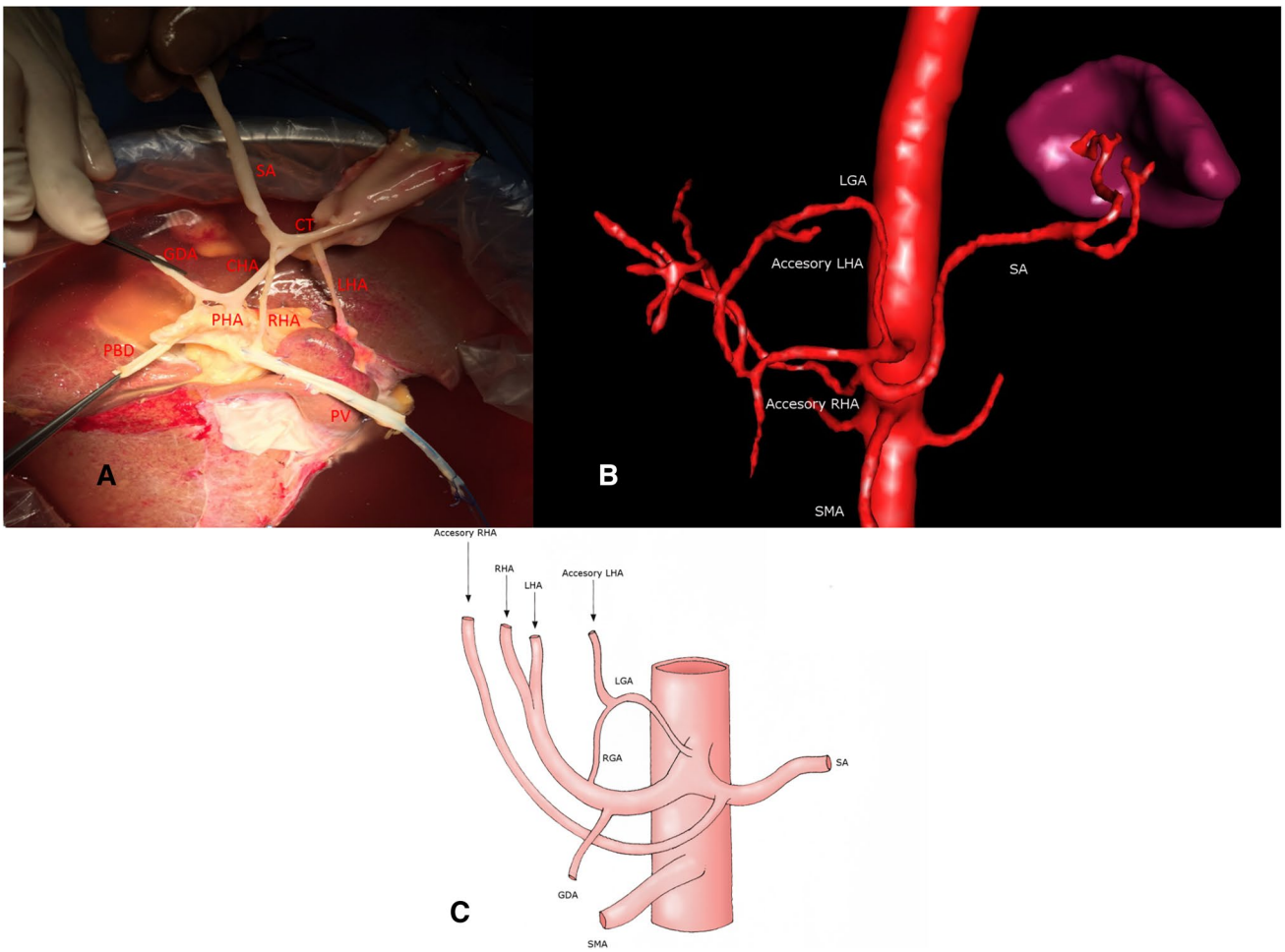

Fig. 1 **a** Back-table dissection of the specimen. **b** Visible Patient 3D reconstruction based on the preoperative CT-scan. **c** Schematic representation of the anatomic variation encountered (*PHA* proper hepatic artery, *RHA* right hepatic artery, *LHA* left hepatic artery, *GDA* gastro-duodenal artery, *LGA* left gastric artery, *RGA* right gastric artery, *SMA* superior mesenteric artery, *SA* splenic artery, *CHA* common hepatic artery, *CT* coeliac trunk)

demanding splitting liver procedures such as A.L.P.P.S., in situ split, ex situ split and living donor liver transplantation. The particularity of our case is the presence of two accessory hepatic arteries for the left and right lobes. If we were to expand the Kobayashi classification to include this anatomic variant, it would be a "I-I plus Y :SA LGA CHA", where SA stands for splenic artery, CHA stands for common hepatic artery and LGA stands for left gastric artery (Fig. 1c).

In our opinion such an anatomical variant, even though rare, is not completely surprising if we take into account the embryological development of the liver and its arterial vascularisation. Thus, it is known that the liver primordium originates from three different parts—a right later, a left lateral and a middle part, each of them with their hepatodigestive arterial branch. The left branch for the left lateral segment gives off the future left gastric artery. The middle branch arises from the junction between the gastroduodenal artery and the common hepatic artery. The right branch arises from the omphalomesenteric artery and in most cases it is obliterated by the time of birth. However in cases where it is not obliterated during embryogenesis it is found originating from the superior mesenteric artery near its root [3].

At the same time we need to take into account the presence of the longitudinal anastomosis system described by Tandler explaining vertical coelio-mesenteric and intermesenteric arcades. Such an arcade is the Buhler arcade which is a communication between the coeliac trunk or the origin of one of its branches and the superior mesenteric artery [3].

While the presence of an accessory left hepatic artery originating from the left gastric artery is quite often and easily explained embryologically, the presence of a second accessory right hepatic artery originating from the splenic artery is more difficult to explain but can be due to the presence of an incompletely obliterated right hepatic branch and a migration of the insertion of the Buhler arcade which instead of merging into the superior mesenteric artery continues with the embryological right hepatic branch creating the accessory right hepatic artery we found.

Another aspect we would like to draw attention to is that as can be seen from the CT reconstruction the medical imaging capabilities of our time have achieved such a degree of performance that they can obtain accurate anatomical information in the pre-operative setting which allow for pre-operative strategy planning and which in time could, through augmented reality techniques, help surgeons even during the surgical procedure itself to avoid damage to such atypical but highly important vessels.

Conclusions

Precise preoperative evaluation of liver blood supply has great importance on surgical, transplantation strategy and outcome. Details of anatomy are not only simple academic knowledge but are deeply involved in practice and every anatomical variant encountered is worth presenting especially one which had never been described before and is now described for the third time in literature within 2 years after its first description.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interest.

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