

Right hepatic artery originated from the superior mesenteric artery: What is the standard anatomic position?

Artéria hepática direita originada da artéria mesentérica superior: Qual seu real trajeto anatômico?

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ABSTRACT

Objective: Liver arterial irrigation is characterized by a high frequency of variations in its anatomy. The aim of the study was to describe the anatomic position of the right hepatic artery as a branch of the superior mesenteric artery. **Methods:** A total of 5147 intravenous contrast-enhanced computed tomography scans of patients seen at the Radiology Service of the Passo Fundo Clinical Hospital (RS), from October 2016 to December 2017, were selected. 125 patients with anatomic variation of the right hepatic artery were selected. The findings were categorized by the variation of the vascular position, emergence from the superior mesenteric artery and the relationship with other structures. **Results:** The most frequent position was retropancreatic (88.8%), retroportal (76.8%) and post-choledocian (75.2%), emerging about 2.33 cm from the superior mesenteric artery. **Conclusion:** We have shown that most common variant of the right hepatic artery presents its posterior origin from the pancreatic and hepatic pedicle, and arises close to the origin of the superior mesenteric artery.

Headings: Anatomy. Liver. Hepatic Artery.

INTRODUCTION

According to the anatomists Testut, Moore, Sobotta, and Netter, the most common right hepatic artery anatomic position is as a branch of the celiac trunk which arises from the aorta. The aorta is the origin of the left gastric artery, splenic artery, and common hepatic artery. The latter is the origin of the gastroduodenal artery and the proper hepatic artery, which is divided into the right and left hepatic arteries, in the hepatic hilum¹. However, variations in the hepatic arterial supply may be seen in 25% to 42% of the cases. Therefore, considering the various common hepatic artery anatomy, it is of utmost importance to be aware of its variations since these may impact procedures in the region. A significant number of complications can be prevented while performing any hepatobiliopancreatic procedure².

Thus, we aimed to describe the Right Hepatic Artery (RHA) anatomical position when arising from the superior mesenteric artery (SMA).

METHODS

The study was approved by the Research Ethics Committee of the Federal University of Fronteira Sul under the number 2,851,249 / 2018 and with a waiver for the informed consent. We retrospectively reviewed 5,147 electronic medical records and abdominal Computed Tomography scans (CT) at the Hospital de Clínicas de Passo Fundo - RS, from October 2016 to December 2017. The data were entered twice in the database in the Epidata Software (3.1). The statistical analyses were performed by SPSS Statistics 20.0 (IBM, United States).

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Quantitative variables were presented as mean \pm standard deviation and qualitative variables as frequency and percentage. We did not perform any statistical analysis hypothesis tests.

The CTs were performed by 16-channel or 80-channel multiple detector CT scanners (both Aquilion, Toshiba Medical Systems, Tokyo, Japan), with intravenous injection of non-ionic water-soluble iodinated contrast media with an iodine concentration of 300 mg/mL. A radiologist with six years of experience in abdominal radiology evaluated the CT scans.

We considered as the normal anatomy, the origin of the celiac trunk from the aorta, branching into the left gastric artery, the splenic artery, and the common hepatic artery. The latter, after the emergence of the gastroduodenal artery, continues as the proper hepatic artery, and branches into the RHA and left hepatic artery in the hepatic hilum (Figure 1). This was considered the typical anatomic position, and when different, it was treated as an anatomic variation, regarding its position with the pancreas, the portal vein, the common bile duct and the distance from the superior mesenteric artery and the right hepatic artery.

RESULTS

A total of 5147 CT scans were analyzed. The patients' average age was 57 ± 16.1 years, and 54.4% were men. Of those, 125 patients (2.42%)

showed an anatomical variation in which RHA originated from the SMA.

Regarding the RHA position that presented variation in its origin, we observed that the most common positions were retropancreatic (88.8%) (Table 1), retroportal (76.8%) (Table 2) and posterior to the common bile duct (75, 2%) (Table 3), and the RHA emerged, on average, 2.33 (+ 0.65) cm from the SMA origin (Figure 2).

Table 1. Hepatic branch position in relation to the pancreas.

Variables	N	%
Posterior to the pancreas	111	88.8
Anterior to the pancreas	14	11.2
Total	125	100.0

Table 2. Hepatic branch position in relation to the portal vein.

Variables	N	%
Posterior to the portal vein	96	76.8
To the right of the portal vein	3	2.4
To the left of the portal vein	1	0.8
Anterior to the portal vein	25	20.0
Total	125	100.0

Table 3. Description of the position of the hepatic branch in relation to the common bile duct.

Variables	N	%
Anterior to the common bile duct	31	24.8
Posterior to the common bile duct	94	75.2
Total	125	100.0



Figure 1. Normal anatomy of the right hepatic artery. 1A: Coronal. 1B: Axial. 1C: Sagittal. * White: Right hepatic artery.



Figure 2. The most common anatomic position of the right hepatic artery branching from the SMA. 1A: Coronal. 1B: Axial. 1C: Sagittal. * White: Right hepatic artery.

DISCUSSION

The anatomy of the hepatic arteries has been the subject of numerous studies over the centuries. The liver, in its classical anatomy, has its arterial irrigation from the branches of the proper hepatic artery (PHA), which is a branch of the common hepatic artery (CHA)^{3,4}. The CHA is one of the three branches that arise from the descending abdominal aorta into the celiac trunk^{5,6}. The anatomy of the extrahepatic arteries is variable, which makes radiological, angiographic and surgical evaluation a difficult task⁷.

Michels' classic study encompassing 200 dissections, published in 1966, defined the basic anatomical variations of the hepatic arteries, and has served as a reference for the vast majority of studies in this area. This classification involves the common hepatic artery, the proper hepatic artery, and the right and left hepatic arteries. Class 1 corresponds to the normal disposition of the hepatic arterial system. Class 2 corresponds to the left hepatic artery branching from the left gastric artery. Class 3 corresponds to the RHA arising from the SMA. Class 4 refers to the multiple aberrant branches, and class 5 corresponds to the common hepatic artery branching from the SMA. Our study has assessed the class 3 position⁵.

Regarding the RHA SMA-originated (Class 3), Michels described it as the most frequent variation.

In the literature, there have been reports for this variation from 8% to 18%^{2,5}. We believe that this variation is more relevant both for its frequency, as well as for its impact on surgical procedures in the hepatic, biliary, and pancreatic regions^{8,9}. The arterial pathway near the inferior vena cava and the portal vein is associated with the risk of inadvertent injuries while performing hepatectomies and pancreatoduodenectomies⁸⁻¹¹. Therefore, to identify and understand the most common course variation preoperatively is essential for those procedures.

Our study demonstrated the variants of the hepatic arterial anatomy. Detailed knowledge of these variants is essential in liver transplantation, as well as when harvesting the liver and the pancreas¹². The existence of a variant of the hepatic artery can increase the risk of injury to the hepatic arterial supply leading to severe hepatic and biliary ischemia. The RHA variant originating from SMA can make it impossible to simultaneously harvest the donor's liver and pancreas. Most complications can be prevented with the adequate identification of the vascular variants, in any of the transplant stages^{8,12,13}.

Anatomical limitations have been extensively studied in bipartitions of liver grafts. With the different anatomical variants of the hepatic artery, the hepatic lobes can receive blood supply from the SMA, left gastric artery, aorta, or from the arterial trunk branching into other abdominal viscera.

Regarding the RHA branching from the SMA trunk, this variant would favor the division between segment IV and the left lateral segment, and the division between segment IV and the right lobe. In these cases, the right lobe of the liver would be prepared along the SMA and the left lobe along the celiac trunk^{14,15}.

Pancreatic surgery also correlates with the arterial variants of the hepatic pedicle. The RHA branching from the SMA usually runs posteriorly along the portal vein, and between the pancreatic head and body. Although the resection of the head of the pancreas is still feasible in the presence of an arterial variant, its presence can cause significant technical difficulty, resulting in conservative resections of the pancreas. In particular, the retropancreatic dissection may result in an inadequate microscopic margin of the tumor, especially regarding the medial retroperitoneal margin. Besides, the attempt to carry out aggressive procedures, in the presence of this variant, can increase surgical time, lead to significant blood losses, and increase postoperative morbidity. However, Eshuis et al. demonstrated that when there is proper preoperative planning, the chances of successfully preserving the arterial branch variant during the intraoperative period are superior to 90%¹⁶⁻¹⁸.

Reconstruction of the variant artery, using autologous grafts or synthetic materials or preoperative embolization may also be options for patients undergoing pancreatic procedures. The goal is to maintain the hepatic arterial and bile duct flow during pancreaticoduodenectomy.

However, Asano et al demonstrated that the RHA resection branching from SMA can be performed in pancreatic resections even when it is technical difficult, without significantly increasing postoperative complications¹⁹.

We have been able to show morphometry and position variants of the RHA branching from the SMA. The frequency of these variants in the 5147 exams was 2.42%. Most studies have reported a higher frequency of the variants, over 10%. Dandekar et al. reported the variant in 22% of their sample, Eshuis et al. in 19%, Michels in 18%, and Hiatt et al. in 10,6%^{5,6,14-16}.

The main strengths of our study are the number of cases and the description of the anatomic positions. We studied 125 variants of the RHA branching from the SMA, while other Brazilian authors assessed fewer patients. Fonseca-Neto et al. reported 27 cases, Balzan et al. 12 cases and Araujo et al. 3 cases^{1,2,18}. To our knowledge our study is the first to describe the most common variants, as the retropancreatic, retroportal, posterior to the common bile duct, and branching about 2.33 cm from the SMA.

CONCLUSION

The RHA branching from the SMA is common, and its position is usually posterior to the pancreas, portal vein, and the common bile duct. Its branching is close to the emergence of the SMA from the descending abdominal aorta.

R E S U M O

Objetivos: A irrigação arterial hepática tem como característica a elevada frequência de variações da anatomia. O objetivo do estudo foi descrever o trajeto anatômico da artéria hepática direita quando originada da artéria mesentérica superior. **Métodos:** Foram analisadas 5147 tomografias computadorizadas com contraste endovenoso de pacientes atendidos no Serviço de Radiologia do Hospital de Clínicas de Passo Fundo - RS, no período outubro de 2016 a dezembro de 2017. Foram selecionados 125 pacientes portadores de variação anatômica da artéria hepática direita na origem. Os achados foram categorizados pela variação do trajeto vascular, emergência da artéria mesentérica superior e a relação com demais estruturas. **Resultados:** Obtivemos o trajeto mais frequente desta variação como retropancreático (88,8%), retroportal (76,8%) e pós-coledociano (75,2%), emergindo cerca de 2,33 cm da origem da artéria mesentérica superior. **Conclusão:** Demonstramos que na maioria das vezes, a artéria hepática direita variante, apresenta trajeto posterior ao pâncreas e ao pedículo hepático e emerge próxima da origem da artéria mesentérica superior.

Descritores: Fígado. Anatomia. Artéria Hepática.

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