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CASE REPORT

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Unusual arterial supply of the segment IV with interlobar bridge and right replaced hepatic artery: a case report

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A replaced right hepatic artery (RHA) arising from the superior mesenteric artery and an interlobar parenchymal bridge over the sagittal fissure have been observed on a 64-year-old formalin-fixed male cadaver in the anatomy laboratory. As we had followed a detailed segmental anatomy, we encountered an arterial distribution of segment IV featuring a different pattern from the literature so far. According to our observations, the segment I is supplied by both left (LHA) and middle (MHA) hepatic arteries; the segments II and III are supplied by the LHA while the segment IV is supplied by both the MHA and replaced RHA. The segments V–VIII are supplied only by the replaced RHA.

The case emphasizes the importance of arterial variations of liver in terms of the surgical procedures during the liver transplantation, hepatic resections, hepatic tumours, and etc. Our discussion focuses to the arterial supply of the segment IV and possible complications it may cause during/after the liver operations. (Folia Morphol 2019; 78, 2: 450–454)

Key words: replaced right hepatic artery, liver, anatomy, cadaver

INTRODUCTION

During the 8th and 10th gestational weeks, hepatic arteries start to be visible in the hepatic hilum and take their last form in the liver parenchyma in the end of 10th gestational week [7]. According to Couinaud classification, three main lobes are described during the embryological stage as the lateral (segment II), medial-anterior (segments III, IV, V, and VIII), and the posterior lobe (segments VI and VII). All of the lobes supplied by an embryonic artery of its own during the development of hepatic formations which are named as the embryonic left, medial, and right hepatic arteries [9]. Development of the intrahepatic arterial formation is parallel to the order of the portal and biliary systems [7]. In the adult liver, the right hepatic artery (RHA) supplies the four segments: V, VI, VII, and VIII; the left hepatic artery (LHA) supplies the lateral superior and lateral inferior segments: II and III, and the middle hepatic artery (MHA) supplies the medial superior and medial inferior segments: segment IV. The caudate lobe (segment I) is supplied by both RHA and LHA [5].

In the literature, hepatic arteries have many variations in terms of their origins. Two main classifications have been described so far: replaced [2, 4, 6, 12, 16] and accessory hepatic arteries [11, 12, 16]. The accessory hepatic artery is present in addition to the main artery of the right and/or left lobes [2, 16] while the replaced hepatic artery originates from another artery instead of the proper hepatic artery (usually

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from the superior mesenteric artery or the coeliac trunk) [2, 12, 16]. The vascular segmental distribution of liver has critical importance in liver transplantation [10, 14]; particularly the segment IV of liver is at greater risk for development of ischaemia, necrosis, and hepatic artery thrombosis as a post-transplant/post-operational complication [1, 14].

In this particular report, we aimed to emphasize the arterial supply of segment IV and replaced RHA (rRHA) with their clinical and morphometric features besides drawing attention to an interlobar parenchymal bridge running between the right and left lobes of liver on its visceral surface.

CASE REPORT

A rRHA (Figs. 1, 2) and an interlobar parenchymal bridge over the sagittal fissure (Fig. 3) have been encountered during a routine abdominal dissection of 64-year-old male cadaver in the Anatomy Department of the Near East University, Faculty of Medicine. The cadaver identification and medical history did not show any of the diseases, abdominal surgeries, or cirrhosis.

In our case the common hepatic artery (CHA) originated from the coeliac trunk (CT) and passed anterior to the portal vein (PV) before it gave off the LHA and the gastroduodenal artery (GA) (Figs. 1, 2). Its length and diameter were measured as 22 mm and 4 mm, respectively.

The LHA arose from the CHA with a diameter of 3 mm and run anterior to the PV. It gave off the MHA 4 mm distal to its origin and ramified into three terminal branches. The terminal branches of the LHA entered into the segments II (dia = 2 mm) and III (dia = 2 mm) of the left lobe. The LHA also gave off small branches (dia = 0.8 mm) to the caudate lobe before it gave off the terminal branches. The length and diameter of the MHA were 41 mm and 2 mm, respectively. The MHA gave five branches off: one of them ran through the umbilical fissure; three of them entered to the segment IV, and one branch entered to the caudate lobe (segment I) (Figs. 1, 2).

The rRHA occurred as arising 20 mm distal to the origin of the SMA, posterior to the PV, and coursed lateral to the PV. The length and diameter of the rRHA were measured as 77 mm and 3.5 mm, respectively. It divided into two thick branches in Calot's triangle; one of these branches (with dia = 2 mm) entered into the liver segments V–VIII while the other one gave off the cystic artery (dia = 1.5 mm) and entered into the segment IV (dia = 2 mm) (Figs. 1, 2). The cystic

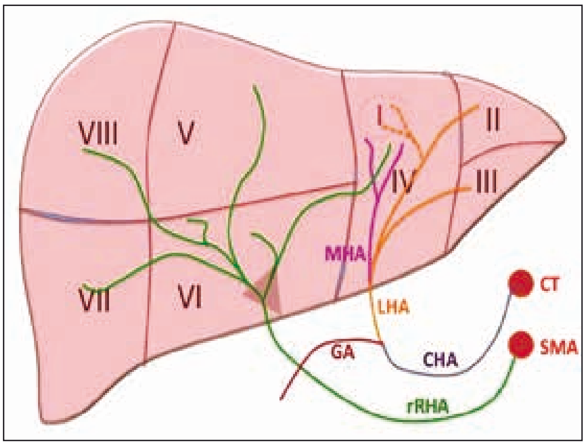

Figure 1. Schematic drawing showing the segmental distribution of hepatic arteries; I–VIII — segments of liver; CHA — common hepatic artery; CT — coeliac trunk; GA — gastroduodenal artery; LHA — left hepatic artery; MHA — middle hepatic artery; rRHA — replaced right hepatic artery; SMA — superior mesenteric artery; Triangle — Calot's triangle.

artery separated into two branches on its course; one ran superiorly and supplied the anterior surface of the gallbladder and it ended in the right lobe while the other branch supplied the cystic duct and reached the gallbladder, inferiorly (Fig. 1). In our case the arterial supply to the segment IV was showing a significant difference as it is supplied by the branches from both MHA and the rRHA that was originated from the superior mesenteric artery.

In addition to the deviation on the arterial supply of the segment IV, there was an interlobar parenchymal bridge running between the right and left hepatic lobes on its visceral surface right behind the sagittal fissure. It was 2 cm long and 2 cm inferior to porta hepatis as appeared on Figure 3. The bridge can also be described like it was where the sagittal fissure missing or became a tunnel with an uninterrupted parenchyma in between the right and left lobes. We could not trace the arterial structure within the bridge, but when we split the tissue parallel to the sagittal fissure, we observed that the round ligament of liver was located right in front of it.

DISCUSSION

In the literature, 10 variant subtypes of the hepatic arterial system were reported by Michels [16] and 6 subtypes were described by Hiatt et al. [12]. Our case is in accordance with both Michels's and Hiatt's classification as type III (as the RHA is being originated from the superior mesenteric artery).

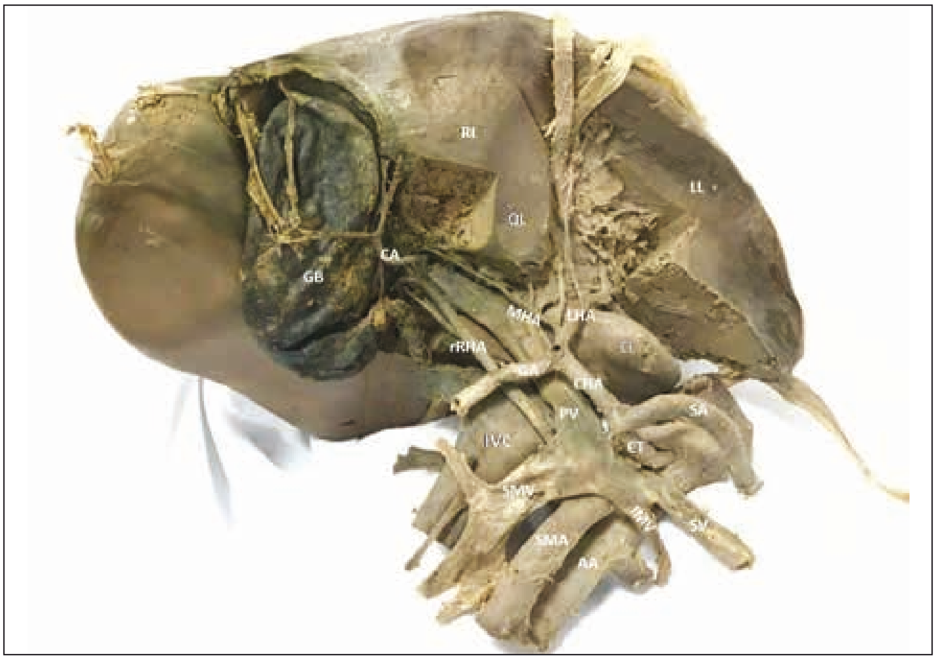

Figure 2. Visceral surface of liver showing the hepatic arteries; AA — abdominal aorta; CA — cystic artery; CHA — common hepatic artery; CL — caudate lobe; CT — coeliac trunk; GA — gastroduodenal artery; GB — gallbladder; IMV — inferior mesenteric vein; IVC — inferior vena cava; LHA — left hepatic artery; LL — left lobe; MHA — middle hepatic artery; PV — portal vein; QL — quadrate lobe; RL — right lobe; rRHA — replaced right hepatic artery; SA — splenic artery; SMA — superior mesenteric artery; SMV — superior mesenteric vein; SV — splenic vein.

Figure 3. Photograph showing the interlobar bridge over the sagittal fissure on the visceral surface of liver; AA — abdominal aorta; CA — cystic artery; CHA — common hepatic artery; CL — caudate lobe; CT — coeliac trunk; FL — falciform ligament; GA — gastroduodenal artery; GB — gallbladder; IVC — inferior vena cava; LHA — left hepatic artery; LL — left lobe; MHA — middle hepatic artery; RL — right lobe; rRHA — replaced right hepatic artery; SA — splenic artery; SMA — superior mesenteric artery; red circular line showing the interlobar bridge.

The vascular segmental distribution of liver has critical importance during the liver transplantations [1, 5, 10, 21]; particularly the segment IV is at greater risk as it may cause a hepatic artery thrombosis as a post-transplant complication [10, 13, 14]. The MHA generally supplies the segment IV [10]. In the literature, researchers reported that the MHA originated in about equal proportions from the RHA and the LHA [12, 21] whereas some studies showed that the MHA originates from the LHA more often than from the RHA [17, 20]. Wang et al. [21] reported that MHA could originate from the RHA in the presence of a replaced LHA as well as from the LHA in the presence of rRHA as seen in our case. Recent studies show that the MHA diverged from the LHA in 54–61.5% of the cases while originated from the RHA in 27.5–34% of the cases [17, 20], also the MHA originated from both the RHA and LHA in 5.5% of the cases [17]. The origin of the MHA may also be very important for some of the clinical practices such as a right lobe resection and/or pancreaticoduodenectomy operations. Interestingly, MHA originated from the LHA could also originate from the RHA, especially in the presence of a replaced LHA according to Azoulay et al. [3].

In our case, both rRHA and MHA occurred as supplying the segment IV indicating a possible increased risk of intraoperative injury to the MHA during right/left lobe living donor liver transplantation. Furthermore, complications of surgery such as bleeding would be eliminated by acknowledging the relationship of rRHA with the PV [19]. In our case, rRHA coursed posterior to the PV first and then it coursed laterally and superiorly as it goes farther from it.

As for the parenchymal interlobar bridge, it seemed to be a continuous parenchymal tissue jumping over the sagittal fissure in between the right and left lobes creating a gross anatomical variation, yet we could not trace its vascular structure. The sagittal fissure partially has become a 2 cm long tunnel right in front of the parenchymal bridge, 2 cm inferior to the porta hepatis. We have come across a similar case in a report of Ebby et al. [9]. They reported the sagittal fissure have become a complete tunnel having the round ligament in it with a missing quadrate lobe [8]. Our case shows a normal quadrate lobe as seen in Figure 3.

CONCLUSIONS

The origin, diameter, length, course and segmental distribution of the hepatic arteries are important for surgical/invasive approaches to the liver both in living donor and split liver transplantations. The present case with the segment IV supplied by both the rRHA and MHA is of great importance due to their possible implications in liver transplantations/surgeries. There is also a possibility to interrupt the blood supply to the liver when there is pancreaticoduodenectomy attempted to the patients with rRHA [15, 21, 22]. It should always be kept in mind that the origin of the hepatic artery and/or its branches may show many variations and should be under consideration beforehand the planned surgery. Also, using a multidetector computed tomography angiography can detect the rare hepatic arterial vascularisation [18].

The parenchymal variations like the one we have reported in this case should be kept in mind in terms of possible vascular variations associated their development.

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