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Case Report

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A rare type of hepatobiliary arterial system in man – presence of accessory left and replaced right hepatic arteries and double cystic arteries

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Abstract

In addition to the normal textbook description, the hepatobiliary arterial system in man shows many anatomical variations that have definite clinical importance. The presence of aberrant hepatic and cystic arteries may lead to a number of iatrogenic injuries during some open surgical or endoscopic procedures. In the course of routine students' dissection of a 62-year-old Caucasian female cadaver, an interesting pattern of the arterial supply to the liver and gallbladder was described. In the case reported, an unusually small proper hepatic artery was identified supplying the left liver lobe. In addition, an accessory left hepatic artery was also observed arising from the left gastric artery. Another large variant artery to the liver was also dissected that started from the first portion of the superior mesenteric artery – known as replaced right hepatic artery. The gallbladder, in this case, had two supplying arteries of different origin arising from the small proper hepatic artery and replaced right hepatic artery. This rare and complicated arterial variation might be of considerable importance for liver and gallbladder resections, liver transplants and laparoscopic procedures in this area.

Keywords: accessory left hepatic artery; double cystic artery; hepatobiliary arterial system; replaced right hepatic artery; variation

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Introduction

The anatomy of the hepatobiliary arterial system is of considerable importance in general and laparoscopic surgery, liver transplants and radiological procedures. In the dominant pattern, the liver is supplied by the left and right hepatic arteries – both branches of the proper hepatic artery.[1] On the other side, the gallbladder receives its blood supply from the superficial and deep branches of the cystic artery usually arising from the right hepatic artery within the cystic triangle of Calot.[1] Despite this well-known textbook's description, the vascular anatomy of the hepatobiliary system may be quite variable. As a rare occurrence, aberrant arteries to the liver are described that are termed either "accessory" or "replaced". A vessel which supplies a liver lobe in addition to its normal vessel is defined as an accessory hepatic artery (AcH). A replaced hepatic artery (RpH) is a vessel of unusual origin that is the sole supply to the respective liver lobe.[1] In 1966 Michels[2] first proposed a classification for the variant blood supply of the liver. Later, Hiatt[3] made modifications using the results from studying 1000 donor livers. Likewise, in the literature there are other studies identifying and classifying hepatic and cystic arteries variations.[4-12] In this study, we present a rare combination of variations in hepatobiliary arterial system not found in the literature. We report the presence of an accessory left hepatic artery (AcLH), replaced right hepatic artery (RpRH) and double cystic arteries in one and the same body.

Case Report

During routine anatomical dissection of a 62-year-old Caucasian female cadaver, an interesting pattern of the arterial supply to the liver and gallbladder was described. The first of the findings were noted while dissecting the content of the lesser omentum (**Figures 1a** and **b**). A common pattern of the celiac trunk was identified, that trifurcated into a large left gastric artery (as its first branch) and

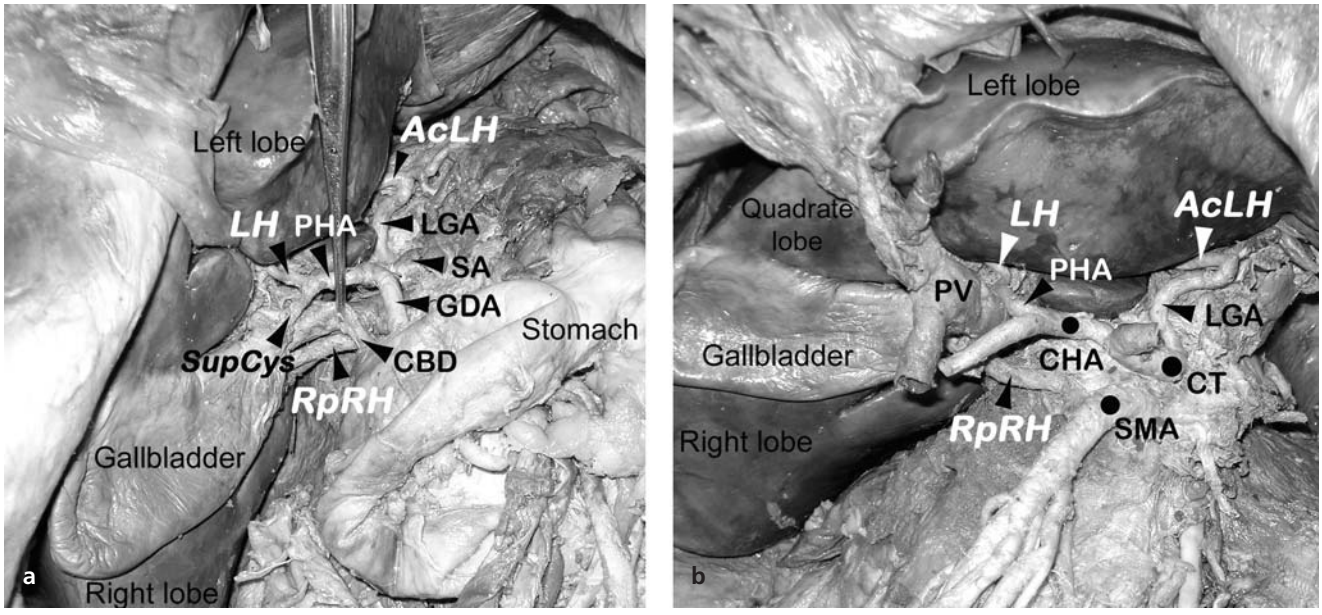

Figure 1. Anterior view of the abdominal cavity during the initial dissection (**a**) and after removal of the stomach (**b**). Arteries: **AcLH:** accessory left hepatic artery; **CHA:** common hepatic artery; **CT:** celiac trunk; **GDA:** gastroduodenal artery; **LGA:** left gastric artery; **LH:** left hepatic artery; **PHA:** proper hepatic artery; **RpRHX:** replaced right hepatic artery; **SA:** splenic artery; **SMA:** superior mesenteric artery; **SupCys:** superficial cystic artery. Biliary tract: **CDB:** common bile duct. Veins: **PV:** portal vein.

after that into the splenic and common hepatic arteries. Behind the duodenum, the latter gave rise to the gastroduodenal artery and unusually small proper hepatic artery (diameter 2.8 mm) that coursed superiorly toward the liver, on the left side of the common bile duct. Within the cystic triangle of Calot, the proper hepatic artery was located in front of the cystic duct and finally entered the porta hepatis continuing solely as a small vessel to the left liver lobe. Before entering the liver, this artery gave rise to a superficial cystic artery supplying the free peritoneal surface of the gallbladder. The unusually large left gastric artery (diameter 4.8 mm) coursed upward and anteriorly and after giving rise to two small branches to the lesser curvature of the stomach, it continued as an AcLH. This vessel (diameter 4.6 mm) coursed anteriorly deep within the fissure of the ligamentum venosum toward the porta hepatis and entered into the left lobe of the liver. Within the free border of the lesser omentum, behind the cystic and common bile ducts and lateral to the portal vein, another large variant artery was also identified (**Figures 2** and **3**). Careful dissection revealed the presence of a RpRH of significant size (diameter 5.4 mm) arising from the first portion of the superior mesenteric artery behind the neck of the pancreas. From its origin, the RpRH ascended to the porta hepatis to finally enter into the right liver lobe. From this artery at the level of the neck of the gallbladder a deep cystic artery arose that supplied the embedded in the liver surface of the gallbladder. No other vascular anomalies were identified in the splanchnic area in this case.

Discussion

According to the classical work of Adachi,[4] an AcLH was observed in 12.3% of the bodies dissected. In the study of Michels,[2] the AcLH accounted for 8% of the cases while the RpRH from the superior mesenteric artery was established in 11%. In the classification of Hiatt,[3] the replaced and accessory hepatic arteries were given mixed in the different categories, so a precise incidence related to our case can not be extracted. According to Clemente,[1] an aberrant hepatic artery branches from the left gastric in nearly 23% of the cadavers studied. In about half of the cases, this aberrant artery completely replaced the left hepatic artery, while in the other half it is just additional to the main artery (AcLH). Because of this fact, the left gastric has been termed "gastrohepatic artery" by Haller as early as 1756 – cited by Clemente.[1] In the study by Covey et al.[5] on 600 patients that underwent visceral angiography, an AcLH from the left gastric artery was seen in 15% of the cases (90 patients). In the same study, the RpRH from the superior mesenteric artery was identified in 12.2% (73 patients). Abdullah et al.[6] examined by means of surgical arterial dissection 932 cases in liver transplantation and reported the incidence of AcLH from the left gastric and

RpRH from the superior mesenteric artery in 6.4% (59 patients) of the cases. Reviewing the data from 200 CT scans, Prabhasavat and Homgade[7] found a prevalence of RpRH originating from the superior mesenteric artery in less than 0.5%. In an analysis with multidetector CT angiography of 100 patients Ugurel et al.[8] found the AcLH in 10% of the cases and the RpRH in 11%; also a combination of AcLH from the left gastric and RpRH from the superior mesenteric artery was considered quite rare and observed in just 1% of the cases. Unusual origin and branching patterns of the hepatic arteries have also been reported by Gielecki et al.,[9] Mugunthan et al.,[10] Nayak and Vasudeva,[11] and Singh et al.[12] What makes this case very rare is the unique combination of the aberrant hepatic arteries with the variant arterial supply of the gallbladder. In a study of 29 bodies, Yabuki – cited by Adachi[4] - found doubled cystic artery in 10.3% (3 cases). In a basic article on the surgery of the gallbladder, Anson[13] has stressed on the clinical significance of the gallbladder vascular supply and also reported some variations of the cystic arteries including the rare occurrence of dual cystic arteries. Hugh et al.[14] have considered the doubling of the cystic artery, found in 22% of the patients, as the most important variation seen through the video laparoscope. Based on a study by means of 64-detector row CT before laparoscopic cholecystectomy, Sugita et al.[15] reported the presence of two cystic arteries in 19% of the patients. Loukas et al.[16] have reported an interesting case of variations in the hepatobiliary arterial system with double cystic arteries – both arising from the system of the common hepatic artery. Ding et al.[17] classified the anatomic variations of the cystic arteries found during laparoscopic cholecystectomy and reported the presence of two cystic arteries, both arising from the right hepatic artery ("Calot's triangle type") in 12.2% of the patients.

Awareness of the variant anatomy of the hepatobiliary system is a key for the safe execution of any operative procedure. In the field of biliary tract surgery misinterpretation of these variances can cause major complications.[14,18] Fathy et al.[19] have stated that laparoscopic cholecystectomy was complicated by inadvertent injury of the cystic artery in 0.85% of the cases. Proper identification by dissection, ligation and cutting of the cystic arteries is an essential step in cholecystectomy.[20] In a massive analysis of 9542 consecutive laparoscopic operations, Duca et al.[21] reported that the main intraoperative complication is hemorrhage in 224 cases (2.3%). Conversion to open surgery was necessary for 184 patients (1.9%), mostly due to obscure anatomy. On the other side, hepatic transplantation depends on meticulous recognition of liver vascular anatomy. Variant

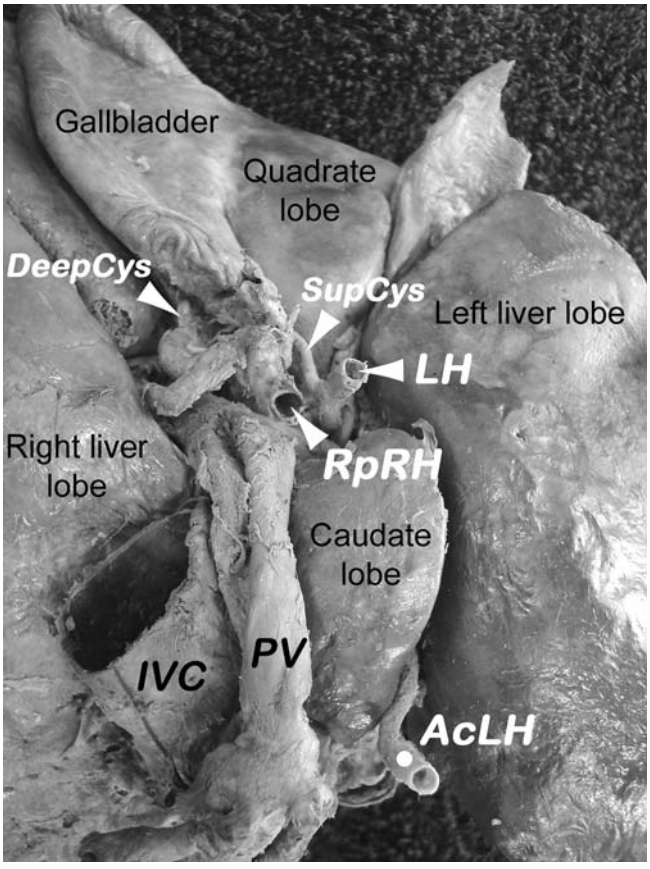

Figure 2. Visceral surface of the liver after its removal and vessel transection. Arteries: **AcLH:** accessory left hepatic artery; **DeepCys:** deep cystic artery; **LH:** left hepatic artery; **RpRH:** replaced right hepatic artery; **SupCys:** superficial cystic artery. Veins: **IVC:** inferior vena cava; **PV:** portal vein.

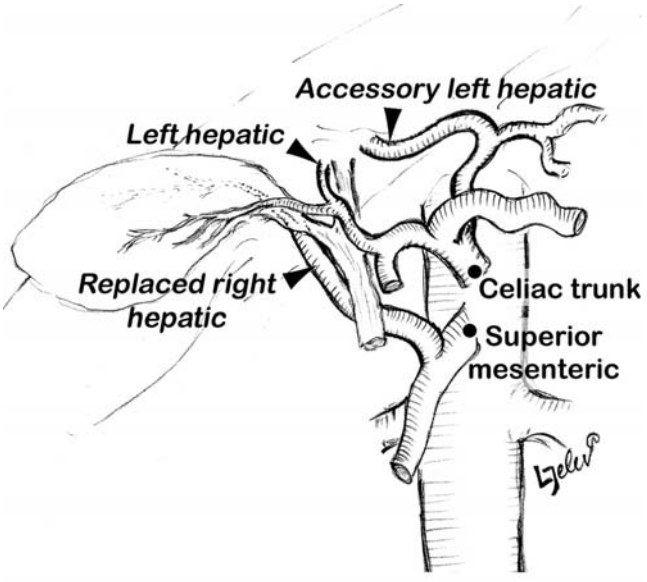

Figure 3. Common scheme of the reported arterial variations.

hepatic anatomy must be appropriately managed during split liver transplantation, a technique in which 2 recipients receive grafts from a single donor, to ensure complete vascular supply.[6,22] A detailed apprehension of all possible combination is needed to avoid vascular complications, especially for liver transplantations, interventional radiology and laparoscopic procedures.

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