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A rare branching pattern of the celiac trunk associated with an accessory aberrant cystic duct

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ABSTRACT

During routine educational dissection of the upper part of the abdominal cavity in a female cadaver (67 years old, Netherlands) a unique association of two rare biliary and vascular patterns was discovered.

The gastroduodenal artery originated from the celiac trunk along with the right hepatic, gastric and splenic arteries, and gave origin to the accessory right and left hepatic vessels. The right hepatic artery took the course typical for the common hepatic artery; however, as a component of the portal triad, the artery was located behind the bile duct and portal vein. Next to the hilum of the liver, it branched off the cystic artery to the gallbladder and bifurcated into two segmental hepatic branches. The described hepatic vascular pattern was associated with the presence of an accessory aberrant cystic duct connecting the body of the gallbladder with the right anterior inferior segmental bile duct.

The case is reported to emphasize the importance of a detailed preoperative investigation of the patients considered for open and laparoscopic procedures on the liver and gallbladder documenting the variability of both the biliary and vascular patterns.

Keywords: gastroduodenal artery, celiac trunk variability, accessory retroportal right hepatic artery, aberrant accessory cystic duct.

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Introduction

The typical gastroduodenal artery is a branch of the common hepatic artery that descends behind the first part of the duodenum and then divides into the right gastroepiploic and superior pancreaticoduodenal arteries. The common hepatic artery branches out of the celiac trunk, along with the left gastric and splenic arteries, and runs toward the porta hepatis to give off right and left hepatic arteries.

The conventional anatomy of the celiac trunk and its branches is found in 60 to 90% of cases, depending on the study [10, 12, 17]. The possible variations of origin of the common hepatic artery from the splenic (4.5%), mesenteric (2.5%), celio-mesenteric (1%), and spleno-mesenteric (0.7%) arteries were summarized in Michel's classification of types of hepatic blood supply [10]. Accessory aberrant hepatic arteries branching off from the superior mesenteric and left gastric arteries were encountered in 3.2% and 3.0% of studied cases, respectively [3].

The gastroduodenal artery is considered to be one of the most stable splanchnic arteries [7]. The high origin of the gastroduodenal artery from the celiac trunk is revealed only in 0.03 – 0.05% of cases and is one of the rarest patterns described [9, 10]. Abnormal origin of the gastroduodenal artery is typically associated with the presence of accessory aberrant hepatic arteries and with the reposition of the common hepatic artery that significantly alters the contents of porta hepatis [11]. Such anomalous hepatic blood supply is a challenge for surgeons performing open cholecystectomies and liver transplantations, not to mention specialists employing the laparoscopic and transvascular non-invasive techniques [2, 3, 17]. The co-existence of atypical hepatic vascular patterns with biliary duct anomaly compromises outcomes of the surgical procedures on the gallbladder and liver even more [14].

The various biliary duct patterns are described in 50% of patients, and are characterized by a high (11%) or low (18%) insertion of the cystic duct into the common hepatic duct, a parallel course of cystic duct (15%), a cystic duct draining into the right hepatic duct (0.5%), or a sectoral hepatic duct draining to the cystic duct (0.5%) [5, 8, 13]. Presence of the aberrant accessory cystic duct without duplication of the gallbladder is an extremely rare anatomic variability [1, 4].

In the present paper, a rare and clinically significant variation of the biliary and vascular hepatic patterns is reported. The case includes: 1) a high origin of the gastroduodenal artery from the celiac trunk, 2) a right and left accessory aberrant hepatic arteries branching off from the anomalous gastroduodenal vessel, 3) a retroportal position of the right hepatic artery, and 4) the presence of an aberrant accessory cystic duct.

Case report

During routine educational dissection of the upper part of the abdominal cavity in a female cadaver (67 years old, Netherlands) a unique combination of atypical vascular and bile ducts patterns was discovered. The dissection was carried out in the educational laboratory following the international ethical standards.

The celiac artery gave origin to the gastroduodenal artery, which made a 12 mm long common gastroduodenogastric trunk with the common gastric artery. The other two vessels arising from the celiac trunk were the right hepatic artery and the splenic artery (Figure 1).

The gastroduodenal artery first ran towards the porta hepatis giving off accessory left and right hepatic branches, then looped downward crossing the bile duct and portal vein vertically, and terminated behind the superior part of the duodenum bifurcating into the right omentoepiploic and the only pancreaticoduodenal branches. While the omentoepiploic artery took its usual course and anastomosed with the left omentoepiploic one, the pancreaticoduodenal arterial supply was performed by the only dominant vessel

descending along the middle wall of the duodenum and giving off several branches to supply it. The terminal pancreatic branch turned around the head of the pancreas and continued along its lower margin. The 36 mm long common gastric artery divided into the left and right gastric arteries approaching the lesser curvature of the stomach (Figure 1).

In the point of its origin, the right hepatic artery took the course typical for the common hepatic artery; however, as a component of the portal triad, the artery was located behind the bile duct and portal vein. Next to the hilum of the liver, it bifurcated into two segmental branches entering the right lobe of the liver. The cystic artery branched off from the inferiorly located segmental branch taking the deepest position possible in relation to the other structures of the portal triad (Figure 2).

The described hepatic vascular pattern was associated with the presence of an accessory aberrant cystic duct connecting the body of the gallbladder with the right anterior inferior segmental bile duct (Figure 3). The right hepatic bile duct was formed as a result of a fusion of the accessory aberrant cystic duct with the segmental one. The common hepatic duct was characterized by a high junction of the lobar ducts. The regular cystic duct showed a high insertion into the common hepatic duct, entering it as far as 2.1 cm from the porta hepatis.

Figure 1. Cadaver dissection view. Variability of the branching pattern of the celiac trunk showing a high origin of the gastroduodenal artery (GD) which forms a common trunk (GDG) with the common gastric (CG) artery. The gastroduodenal artery gives off the left and right accessory hepatic arteries (ALH, ARH), while the common gastric artery divides into the left and right gastric arteries (LG, RG). The other vessels presented on this picture are the right hepatic artery proper (RHA) and the splenic artery (SA).

Figure 2. Cadaver dissection view. Atypical relationships of the structures of the portal triad with the superficially located gastroduodenal artery (GD) overlying the portal vein (PV) and the common bile duct (CBD). The right hepatic artery takes the deepest position in the portal triad, and, approaching the hilum of the liver, gives off two segmental branches (sbRH) and a cystic artery (CA).

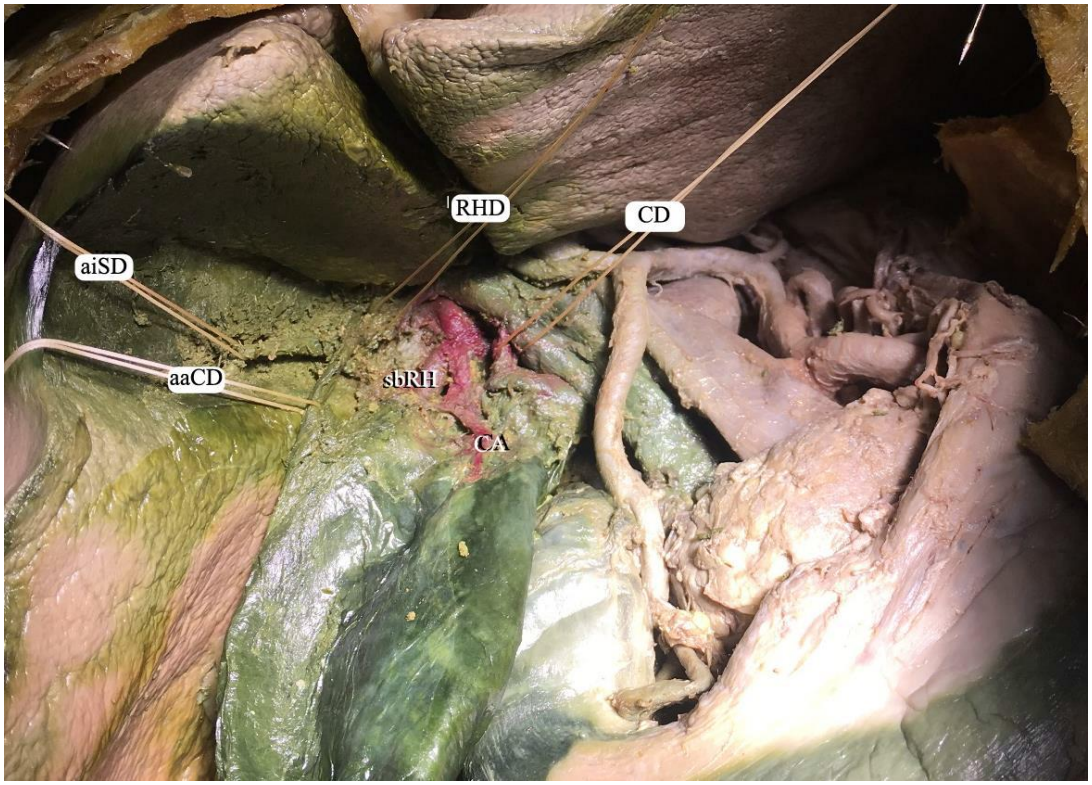

Figure 3. A variability of the biliary tract. The accessory aberrant cystic duct (aaCD) connects the body of the gallbladder with the right anterior inferior segmental duct (aiSD) and continues with the right hepatic duct (RHD). The cystic duct proper (CD) shows a high junction with the common hepatic duct (CHD). The cystic artery (CA), and the segmental branches of the right hepatic artery (sbRH) are colored red for clarification in this figure.

Discussion

The high origin of the gastroduodenal artery from the celiac trunk is one of the rarest and potentially most risky anatomical variations of the arterial distribution of upper abdomen [9, 10, 12]. Although there is only one report of such an anomaly available in the literature [2], we can assume, however, that the common hepatic artery or the vessel which it replaces, such as the right hepatic artery in our case, shows the tendency to occupy the retroportal position in the portal triad. Bearing in mind that the cystic artery branches out from the right hepatic artery even if the last one takes an aberrant course and begins from the superior mesenteric or gastroduodenal arteries, such variation represents a high risk for surgery on hepatobiliary tract [3, 11, 17]. The co-existence of the retroportal right hepatic artery with the aberrant accessory cystic duct makes the presented case even more unfavorable for surgery, as a failure to recognize the accessory cystic duct may lead to bile leakage, biliary peritonitis, or the formation of a fistula [1, 14]. Such combination is a particular hazard in the laparoscopic conditions when extended visualization of the bile ducts and hepatic vessels is limited, and the success of an operation depends on thorough preoperative investigation [5].

If the high origin of the gastroduodenal artery from the celiac trunk is revealed in the preoperative stage, we advise considering a possible re-arrangement of the components of the portal triad. In such cases, the structures included into the portal triad tend to take a four-layered shape: 1) the accessory right and left hepatic branches arising from the atypical gastroduodenal artery, 2) the common hepatic bile duct and portal vein, 3) the right hepatic artery with two terminal segmental branches, 4) the cystic artery bounded by the regular cystic duct medially and by the accessory aberrant cystic duct laterally (Figure 2).

Formation of the preliminary vascular and biliary trees is a result of complex processes of proliferation, differentiation, and migration of endothelial stem cells [6, 15]. With the progress of angiogenesis, the primitive celiac trunk and superior mesenteric artery sprout off from 10th to 13th vitelline arteries connecting the aorta to the primitive ventral anastomotic artery. The 11th and 12th vitelline arteries normally undergo complete regression, while the 10th and 13th ones develop into the celiac trunk and superior mesenteric artery. The ventral anastomotic connection between the primordia of the unpaired branches of the aorta may persist in the form of the arc of Buhler, or undergo particular regression leading to alteration of the direction of the blood flow and persistence of the rudimental vitelline arteries [11, 16]. That results in the formation of the celiacomesenteric and hepatomesenteric trunks, in the aberrant origin of the common or right hepatic artery from the superior mesenteric or gastroduodenal arteries, as well as in the presence of the accessory hepatic vessels [12].

The traditional embryologic concept fails to explain the formation of the vascular pattern presented in our case. Taking into account the recent findings on the genetic regulation of angiogenesis [6], the sprouting of the gastroduodenal artery from the 10th vitelline artery may be a result of proximal migration of the receptors initiating the proliferation of the responsible epithelial cells. The similar mechanism of formation of the biliary tree allows us to suggest that hyper-stimulation or reduced suppression of the endothelial sprouting might lead to the development of the accessory cystic duct [15].

The anatomical variation reported in this paper requires urgent attention of the related specialists due to significant alteration of the hepatic vasculature and biliary drainage system that can lead to unfavorable results in related surgical and minimally invasive procedures. Thorough preoperative investigation of the patients considered for intervention on the liver and gallbladder on a subject of variability of both biliary and vascular patterns is essential in such

cases.

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