

Research Article

Origin of cystic artery from hepatic artery proper and its surgical implications

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ABSTRACT

Cystic artery is usually a branch of right hepatic artery given in the Calot's triangle. Variations in the origin of cystic artery have been reported but there is paucity of literature regarding these in Indian subjects. The present case describes the origin of cystic artery from the hepatic artery proper, with an unusual course, which was detected during routine cadaveric dissection. The development of biliary vasculature is quite complex and it accounts for many variations. Knowledge of cystic artery variability facilitates intraoperative identification of vessels in both classical and laparoscopic surgery of the bile ducts. This emphasises the importance of a thorough knowledge of the cystic arterial variations that often occur and may be encountered during both laparoscopic and open cholecystectomy. Uncontrolled bleeding from the cystic artery and its branches is a serious problem that may increase the risk of intraoperative lesions to vital vascular and biliary structures during hepatobiliary surgery.

Keywords: Cystic artery, Hepatic artery proper, Calot's triangle, Anatomical variation

INTRODUCTION

Calot's triangle is defined as a triangle comprising of cystic duct, right hepatic duct and lower edge of liver. Cystic artery normally arises from right hepatic artery within Calot's triangle and passes posterior to the common hepatic duct. Anatomical variations of the cystic artery are very commonly encountered during cholecystectomy. Very often surgeons face problems in laparoscopic cholecystectomy when cystic artery arises outside the Calot's triangle (to the left) and crosses anterior to common hepatic duct.^{1,2} Cystic artery may originate from right hepatic, left hepatic, hepatic proper, gastroduodenal, celiac or superior mesenteric artery. Uncontrolled arterial bleeding during laparoscopic cholecystectomy is a serious problem and may eventually result in open cholecystectomy, hence, the origin and the course of the cystic artery is important.³

METHODS

During routine cadaveric dissection for medical undergraduates, a variation in the origin of cystic artery was observed in a 50 year old female cadaver. The cystic artery originated from the hepatic artery proper which was carefully dissected and delineated from the surrounding viscera and photographed.

RESULTS

The celiac trunk (CT) divided into 3 branches: left gastric artery (LGA), splenic artery (SA) and common hepatic artery (CHA). The common hepatic artery divided into 2 branches- gastroduodenal branch (GDA) and hepatic artery proper (HAP). Cystic artery originated from hepatic artery proper, passed anterior to the common bile duct running through the Calot's triangle and reached gallbladder (Figure 1). No other artery was found to supply the gall bladder.

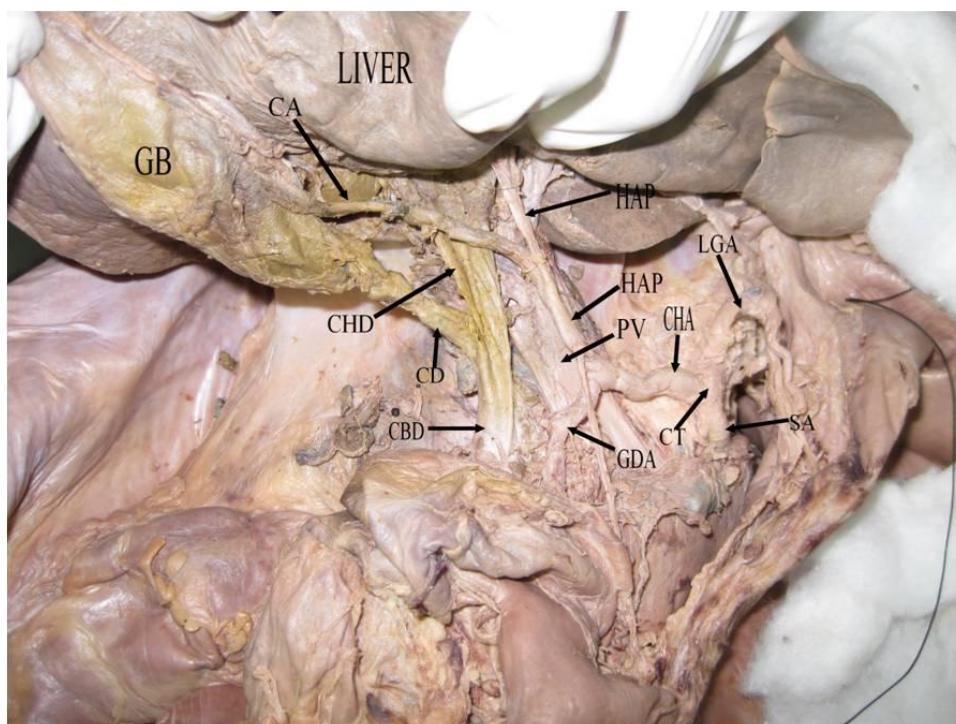


Figure 1: Photograph of the origin of cystic artery (CA) from hepatic artery proper outside Calot's triangle.

CA-cystic artery, HAP-hepatic artery proper, CHA-common hepatic artery, CD-cystic duct, GB-gallbladder, PV-portal vein, GDA-gastroduodenal artery, LGA-left gastric artery, SA-splenic artery, CHD-common hepatic duct, CT-celiac trunk, CBD-common bile duct

DISCUSSION

The cystic artery originates from the following sources: right hepatic (63.9%), hepatic trunk (26.9%), left hepatic (5.5%), gastroduodenal (2.6%), superior pancreaticoduodenal (0.3%), right gastric (0.1%), celiac trunk (0.3%) and superior mesenteric artery (0.8%) (Anson, 1963).⁴ Harris & Pellegrini (1994) noted a little difference in origin, where the right hepatic artery was the main contributor (75%). The other contributors were the left hepatic artery (6.2%), hepatic artery proper (2.2%), common hepatic artery (0.6%), superior pancreaticoduodenal artery (0.2%) and the superior mesenteric artery, but the incidence of the gastroduodenal origin was not different from that reported by Anson (1963).⁵

Cystic artery originating from gastroduodenal artery is also called low-lying cystic artery, which does not pass through Calot's triangle but approaches the gallbladder beyond it. In conventional open cholecystectomy it is seen as inferior to the cystic duct, while it usually localizes superficially and anterior to the cystic duct from a laparoscopic viewpoint. Its terminal segment as it approaches the gallbladder is important for laparoscopic surgeons. Because it not only must be manipulated at

first, but it is also susceptible to injury and hemorrhage during dissection of the peritoneal folds that connect the hepatoduodenal ligament to Hartman's pouch of the gallbladder or to the cystic duct.⁶ This anatomic variation was found in our case in which the cystic artery originated from gastroduodenal artery outside Calot's triangle. Table 1 shows variations in the origin of cystic artery in different studies by Anson, Michels and Moosman.⁷

Table 1: Variations in the origin of cystic artery in different studies.

Origin of cystic artery	Anson	Michels	Moosman
RHA	74.7%	89%	87%
LHA	5.9%	4%	3%
CHA	14.9%	3%	5%
GDA	2.5%	4%	2%
HAP	0%	0%	0%
CT	0%	0%	0%
OTHERS	1%	-	3%

The explanation for the variations in the cystic artery is found in the developmental pattern of the biliary system. Embryologically, the simple branching pattern of the gastroduodenal and hepatobiliary vasculature is profoundly altered by the growth of the liver and pancreas and by the assumption of a curved form in the stomach and duodenum. These factors operate to complicate the branching of the celiac axis and proximal segment of the superior mesenteric artery. Considering that the liver is derived from a portion of the primitive duct supplied primordially by the celiac and mesenteric arteries, it may receive rami from both of these sources. The same is true from the gallbladder. The liver and gallbladder develop from a foregut endodermal hepatic diverticulum, which usually carries a rich supply of vessels from the abdominal aorta and its initial branches. Most of the vessels picked up from the abdominal aorta during development degenerate leaving in place the mature vascular system. Because the pattern of degeneration is highly variable, the origin and branching pattern of the vessels to these organs also vary considerably (Hiatt et al., 1994) Considering the complexity of this developmental scheme it is easy to understand the large degree of arterial variation within this vascular system as described by Daseler et al. Knowledge of the different anatomical variations of the arterial supply of the gallbladder, liver and stomach is of great importance in hepatobiliary and gastric surgical procedures.^{8,9}

Laparoscopic cholecystectomy has been accepted as the preferred method of treatment of gall bladder stones. During laparoscopic cholecystectomy dissection of a limited field is magnified on the video monitor which indicates that a detailed anatomical knowledge of the possible variations in the anatomy of the cystic artery and its branches is very important to the surgeon.¹⁰ The importance of a thorough knowledge of arterial supply of extrahepatic biliary ductal system and its variations lies in the fact that it may help in reducing the uncontrolled bleeding that may increase the risk of intraoperative lesion to vital vascular and biliary structures. Hemorrhage and bile leakage usually occurs due to variants of structures of Calot's triangle and they constitute the most common cause of conversion of laparoscopic cholecystectomy to open cholecystectomy. Accidents

involving vessels or the common bile duct during laparoscopic cholecystectomy, with or without choledochotomy, can be avoided by careful dissection of Calot's triangle and the hepatoduodenal ligament. Our findings should help the surgeons to reduce the incidence of accidents during laparoscopic cholecystectomy.

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