Case Report

Unique origin of cystic artery from celiac trunk and its importance in laparoscopic cholecystectomy

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Abstract

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. Cystic artery is usually a branch of right hepatic artery given in the Calot's triangle .The present case describes the origin of cystic artery from the celiac trunk, 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, celiac trunk, Calot's triangle, anatomical variation.

1 Introduction

The cystic artery usually arise from the right hepatic artery, given off in the Calot's triangle. It has a variable length and enters the gallbladder in the neck or body area. The course and length of the cystic artery in the Calot's triangle is variable. Although classically the artery traverses the triangle almost through its center, it can occasionally be very close or even lower than the cystic duct. When the point of dissection is very close to the gallbladder as in a laparoscopic cholecystectomy or the branching is proximal, one may have to separately ligate the two branches. Also if the presence of a posterior branch is not appreciated it can cause troublesome bleeding during posterior dissection. In addition the cystic artery gives off direct branches to the cystic duct. These small vessels have been better appreciated in the era of laparoscopic cholecystectomy and need to be divided to obtain a length of cystic duct before division (SARKAR and ROY, 2000).

The cystic artery passes behind the common hepatic duct (CHD) to the superior aspect of the gallbladder's neck, where it descends to the body of gallbladder (CHEN, SHYU, CHEN et al., 2000). It bifurcates into a superficial branch, running along the peritoneal surface (subserously) of the gallbladder, and a deep branch, which runs between the gallbladder and the gallbladder fossa. The two arteries anastomose and yield small branches that enter the gallbladder parenchyma (NAGRAL, 2005).

A good knowledge of Calot's triangle is important for conventional and laparoscopic cholecystectomy. Calot's triangle is an important imaginary referent area for biliary surgery. In 1981, Rocko drew attention to possible variations in the region of Calot's triangle bordered by the cystic duct, common hepatic duct, and lower edge of the liver. In 1992, Hugh suggested Calot's triangle should be renamed the hepatobiliary triangle (LOUKAS, FERGURSON, LOUIS JUNIOR et al., 2006).

In its present interpretation of Calot triangle the upper border is formed by the inferior surface of the liver with the other two boundaries being the cystic duct and the bile duct. The left (or medial) boundary of the triangle formed by the bile duct is the most important structure, which needs to be safeguarded (SARKAR and ROY, 2000).

2 Case report

During routine cadaveric dissection for medical undergraduates, a variation in the origin of cystic artery was observed in a 57 year old female cadaver.

After exposing the abdominal cavity and removing peritoneal fat, extrahepatic biliary system was carefully dissected. After identifying the extrahepatic biliary ductal system, attempt to trace its blood supply was made by identifying the abdominal aorta, superior mesenteric artery, celiac artery, hepatic artery, cystic artery, gastroduodenal artery and posterosuperior pancreaticoduodenal artery and their branches. Variations in the origin, position and course of the cystic artery, hepatic arteries, gastroduodenal artery, superior pancreaticoduodenal artery were noted. Special attention was given to the relationship of the cystic artery to the Calot's triangle. The cystic artery originated from the celiac trunk which was carefully dissected and delineated from the surrounding viscera and photographed.

The celiac trunk (CT) gave rise to following branches: left gastric artery (LGA), splenic artery (SA) and common hepatic artery (CHA) and cystic artery (CA).The cystic artery after

its origin from the celiac trunk was passing posterior portal vein and common hepatic duct , then running through the Calot's triangle and reaching the gall bladder (Figure 1). Common hepatic artery arising from celiac trunk divided into hepatic artery proper and gastroduodenal artery. No other artery was found to supply the gall bladder.

3 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%). Harris and 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 (SARKAR and ROY, 2000).

Ignjatovic has divided the cystic artery into three types in minimally invasive surgical procedures: type 1 shows normal anatomy; type 2 more than one artery in Calot's triangle; and type 3 no artery in Calot's triangle. However, none of the above classifications satisfies the practical needs of laparoscopic surgery. The terminal segment of cystic artery is important for laparoscopic surgeons as it approaches the gallbladder. 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 (DING, WANG, WANG et al., 2007). Table 1 shows variations in the origin of cystic artery in different ethnic groups. (CHEN, SHYU, CHEN et al., 2000; BAAKHEIT, 2009; SAIDI, KARANJA and OGENGO, 2007)

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. 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 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. 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. (LOUKAS, FERGURSON,

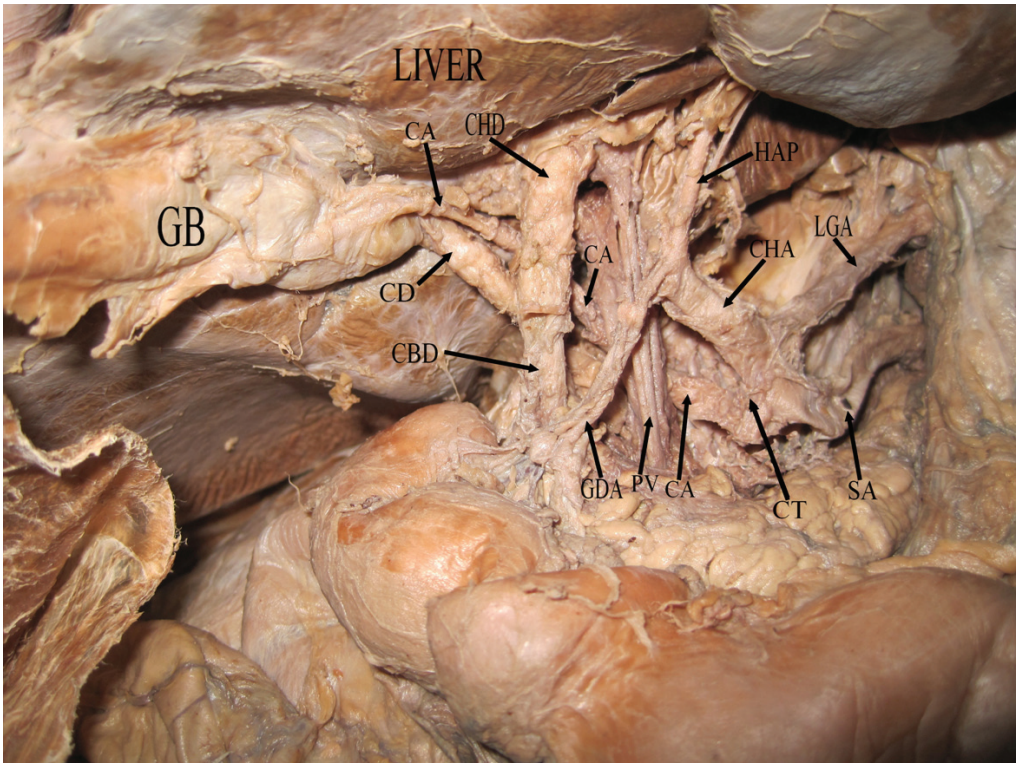

Figure 1. Photograph of the origin of cystic artery (CA) from celiac trunk (CT). CA-cystic artery,HAP-hepatic artery proper, CD-cystic duct, PV-portal vein, GDA-gastroduodenal artery, GB-gallbladder, CT-celiac trunk , CHA-common hepatic artery, CHD-common hepatic duct, CBD-common bile duct, LGA-left gastric artery, SA-splenic artery.

Table 1. Variations in the origin of cystic artery in different ethnic groups.

Origin of cystic artery	Africans (sudanese) (%)	Caucasians (%)	Asians (%)	Africans (kenyans) (%)	Chinese (%)
RHA	78	72	96	92.2	76.6
LHA	2	6	4	0	4
HAP	-	-	-	7.8	4
CHA	17	3	0	0	2.8
GDA	3	1	0	0	1.4
CT	-	-	-	0	1.4
OTHERS	0	17	0	0	9.8

LOUIS JUNIOR et al., 2006; SAIDI, KARANJA and OGENGO, 2007).

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.

The topographical anatomy of the arterial system of the hepatobiliary region and their anomalous origin should be considered during hepatobiliary surgeries. This knowledge is also important for interventional radiologists in routine clinical practice (HLAING, THWIN and SHWE, 2011). Major importance of knowledge of bile duct blood supply may well lie in the understanding of the etiology of postoperative bile duct strictures and in their prevention (NORTHOVER and TERBLANCHE, 1979). Our findings should help the surgeons to reduce the incidence of accidents during laparoscopic cholecystectomy.

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