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ORIGINAL COMMUNICATION

Variant Anatomy of the Cystic Artery in Adult Kenyans

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Knowledge of the variant vascular anatomy of the subhepatic region is important for hepatobiliary surgeons in limiting operative complications due to unexpected bleeding. The pattern of arterial blood supply of 102 gallbladders was studied by gross dissection. The cystic artery originated from the right hepatic artery in 92.2% of cases. The rest were aberrant and originated from the proper hepatic artery. Accessory arteries were observed to originate from proper hepatic artery ($n = 5$), left hepatic artery ($n = 2$), and right hepatic artery ($n = 1$). Most of the arteries approached the gallbladder in relation to the common hepatic duct (anterior 45.1%, posterior, 46.1%). The other vessels passed anterior to common bile duct (2.9%), posterior to common bile duct (3.9%), or were given off in Calot's triangle. Cystic arteries in this data set show wide variations in terms of relationship to the duct systems. In about one tenth of patients, an accessory cystic artery may need to be ligated or clipped during cholecystectomy. Clin. Anat. 20:943–945, 2007.

Key words: cystic artery; variations; cholecystectomy

INTRODUCTION

Misidentification of the biliary anatomy during dissection of the cystic duct and artery are important causes of post-cholecystectomy morbidity. Unexpected bleeding may arise from unusual patterns of the cystic artery (Sarkar and Roy, 2000; Molmenti et al., 2003). Laparoscopic cholecystectomy, usual in developed countries, has only just become established in a few African hospitals with few performers and many learners. An appreciation of hepatobiliary anatomy is even more crucial in this setting. The literature suggests wide variations in the vascular anatomy of the gallbladder, which may in part be explained by ethnic and methodological differences (Sarkar and Roy, 2000; Futara et al., 2001; Molmenti et al., 2003; Larobina and Nottle, 2005). The artery is not always solitary and within the triangle of Calot, which is defined by the common hepatic duct, cystic duct, and liver. The artery may be aberrant in a fifth of individuals (Molmenti et al., 2003). Data from Africa are scarce (Futara et al., 2001). The aim of this article is to report the variant anatomy of the cystic artery in Kenyans.

MATERIALS AND METHODS

One-hundred and two consecutive gallbladders were studied during routine autopsies at the Department of Human Anatomy and the Nairobi City Mortuary. The Department of Anatomy runs a funeral service where autopsies are carried out. All cases with gross hepatic and subhepatic pathologies were excluded. After entry to the peritoneal cavity, the stomach and intestines were mobilized to expose the celiac trunk and its branches. The hepatoduodenal ligament was further dissected to expose the hepatic arteries. The celiac artery was identified by tracing its branches near the gallbladder back to their source. Accessory and aberrant vessels were noted as were the topographic relationships between the cystic artery and the hepatic and bile ducts.

An accessory cystic artery was defined as any artery supplying the gallbladder with an abnormal origin but with the normal artery still present. An aberrant artery was described as any artery supplying the gallbladder with an abnormal origin with the normal artery being absent. The

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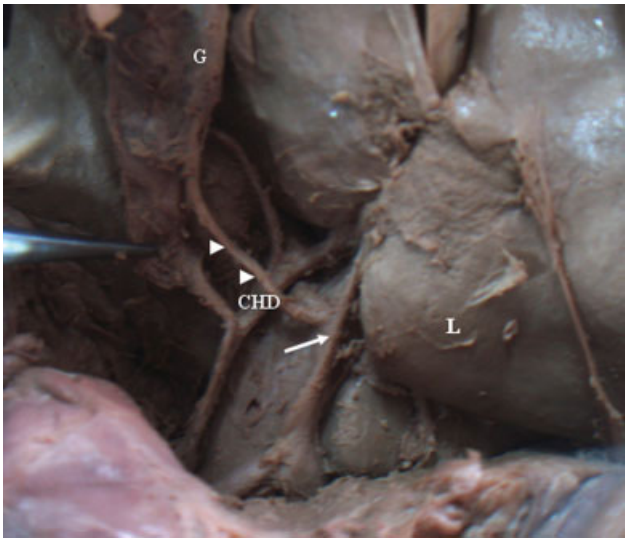

Fig. 1. The cystic artery (arrow heads) originating from the proper hepatic artery (arrow), outside Calot's triangle, and passing anterior to the common hepatic duct (CHD). G, gallbladder; L, liver. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

triangle of Calot was defined by the common hepatic duct, cystic duct, and the liver.

RESULTS

One-hundred and ten cases (age range 18–50 years of age) were available for the study. Eight were excluded due to liver pathology and disrupted subhepatic anatomy. There were a total of 61 men (mean age 32 years) and 41 women (mean age 37 years) examined.

The cystic artery originated from the right hepatic artery in 94 cases (92.2%). Eight (7.8%) vessels were aberrant and originated from the proper hepatic artery (Fig. 1). Accessory arteries were observed in eight cases. Their origins were the proper hepatic artery ($n = 5$), left hepatic artery ($n = 2$), and right hepatic artery ($n = 1$). They followed the normal course of the cystic artery accompanying the normal artery.

The cystic artery passed anterior to the common hepatic duct (Fig. 1) having been given off outside Calot's triangle in 46 cases (45.1%). In 47 cases (46.1%), it was posterior to the common hepatic duct. In the remaining nine cases, seven (6.9%) were related to the common bile duct with three cases (2.9%) anterior and four cases (3.9%) posterior to the duct. Two cases (2.0%) had cystic arteries given off in Calot's triangle (Fig. 2). The relationship to the bile ducts is shown in Table 1.

DISCUSSION

The cystic artery had a normal origin from the right hepatic artery in 92.2% of cases while a single cystic artery supplied the gallbladder in a similar proportion of all cases in this study. These are much higher rates than in available reports. In literature citations, the cystic artery is reported to arise from the right hepatic artery in 70–80% of cases

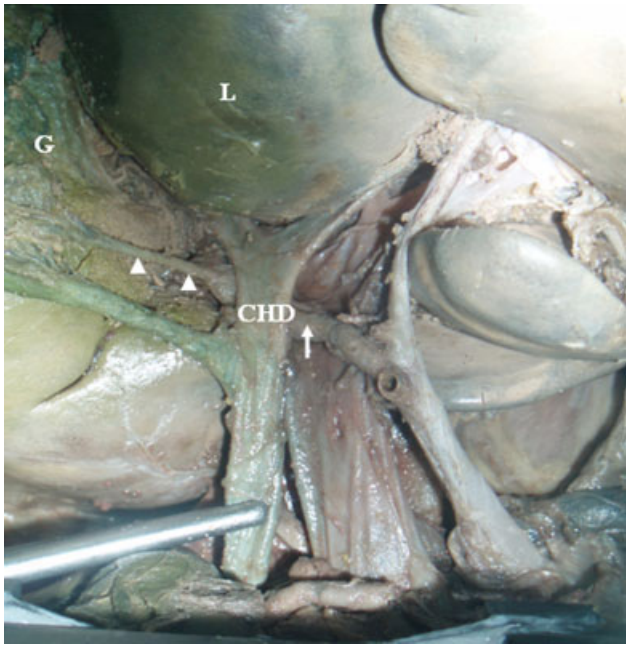

Fig. 2. The cystic artery (arrow heads) arising from the right hepatic artery within Calot's triangle. The relationship of the cystic artery and right hepatic artery (arrow) is posterior to the common hepatic duct (CHD). G, gallbladder; L, liver. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

while a single cystic artery is present in 70–80% (Sarkar and Roy, 2000; Mlakar et al., 2003; Molmenti et al., 2003). Our results suggest a relatively more constant anatomy for the cohort studied than an American series where aberrant arteries occurred in 21% of cases (Molmenti et al., 2003) and that for Ethiopians with a 24.5% prevalence of aberrant cystic arteries (Futara et al., 2001). The lower prevalence of aberrant cystic origins in this study is also at variance with a rate of 23.4% reported among Chinese subjects (Chen et al., 2000). These wide variations are due to methodologic differences but possibly also to actual population differences. Recently, Mlakar et al. (2003) reported an even lower prevalence (53%) for origin from the right hepatic artery in a Slovenian population, but these authors had a separate category for origins from sectoral branches of the right hepatic artery. Cystic arteries originated from these sectoral vessels in 21% of cases. We did not find any subjects with an aberrant origin from the left hepatic, gastroduodenal, celiac, and superior mesenteric arteries, which are said to occur in 20% of dissections (Sarker and Roy, 2000; Molmenti et al., 2003).

TABLE 1. Relation of the Cystic Artery to the Bile Ducts

	Relation to CHD		Relation to CBD	
	Number	Percentage (%)	Number	Percentage (%)
Anterior	46	45.1	3	2.9
Posterior	47	46.1	4	3.9
Total	93	91.2	7	6.9

TABLE 2. Population Comparisons for Origin of Cystic Artery and Its Relation to Common Hepatic Duct

Author	Country of study	Aberrant cystic artery (%)	Course anterior to common hepatic duct (%)
Chen et al. (2000)	China	23.4	7.3
Futara et al. (2001)	Ethiopia	24.5	28.2
Mlakar et al. (2003)	Slovenia	47	
Molmenti et al. (2003)	America	21	
Larubina and Nottle (2005)	Australia		12
This study	Kenya	7.8	45.1

Accessory cystic arteries were present in eight (7.8%) cases. The Ethiopian data documented a prevalence of 10% (Futara et al., 2001), and two cystic arteries supplied the gallbladder in 13.6% of cases reported from Slovenia by Mlakar et al. (2003). The explanation for accessory supplies is found in the developmental pattern of the biliary system. 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). Knowledge of these additional supplies is important as sources of unexpected bleeding when not secured.

Our results on the artery-duct relationship are also at variance with reported studies (Table 2). The vessel followed a course anterior and posterior to the common hepatic duct in about 45.1% and 46.1%, respectively. A posterior relation is more common in many studies. Larobina and Nottle (2005) studied an Australian population and reported the cystic artery to pass posterior to the common hepatic duct in 88% of cases. In a Chinese study (Chen et al., 2000), 72.7% of cystic arteries that originated from the right hepatic artery ran inferior to the common hepatic duct as they entered Calot's triangle. Our study also found the cystic arteries to be related to the common bile duct. It was found anterior and posterior to the duct in 2.9% and 3.9%, respectively. In this situation, the cystic artery may approach the gallbladder inferior to the cystic duct and be liable to injury during the initial dissection at laparoscopic cholecystectomy. Furthermore, in calculous cholecystitis, a cystic artery coursing anterior to the common bile duct may be eroded by stones in the common bile duct. In 2.0% of cases, the artery was not related to either of the ducts and instead supplied the gallbladder after being given off inside Calot's triangle. This relationship has implications in surgery. When both the cystic artery and its parent vessel are within Calot's triangle, the latter is exposed in the limited field of surgery in laparoscopic cholecystectomy and may be damaged during cystic artery dissection (Larobina and Nottle, 2005).

These results add to the body of information of the remarkable and at times contrasting accounts of variant anatomy of the subhepatic region. Surgeons should be aware of the vascular variations during cholecystectomy including the presence of accessory supplies and an atypical relationship with the biliary ducts.

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