

# The cystic artery in human fetuses

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*The cystic artery varies in origin, course and number and it is important to recognise it during operative procedure. Insufficient recognition of its anatomical variation may contribute to a dangerous situation, especially during laparoscopic cholecystectomy. To prevent iatrogenic injuries of the vessels and bile ducts, correct preparation with clear identification of the anatomic structures is essential. Special attention must be given to the course of the cystic artery through the hepato-biliary triangle (Calot's triangle). The assumption of the present study was recognition of the vasculature of the gallbladder in human fetuses. The purpose of this investigation was to determine the origin of the cystic artery and its relation to Calot's triangle.*

*In this study the cystic artery was most often (97.06%) a single vessel and only in one case (2.94%) was it a double vessel. It arose most often (82.34%) from the right proper hepatic artery, rarely from its trunk (8.82%) or its left branch (5.88%) and most rarely (2.94%) from the gastroduodenal artery. In all but one case the cystic artery coursed within Calot's triangle. Its exceptional course out of Calot's triangle concerned a cystic artery originating from the gastroduodenal artery (2.94%). The cystic artery most frequently (67.66%) runs behind the common hepatic duct, rarely (29.40%) over the common hepatic duct and most rarely (2.94%) on the left side of the cystic duct. In the material examined the cystic artery was not observed running in front of the common hepatic duct. The short type of cystic artery trunk (52.93%) was observed more frequently than the long one (44.13%).*

**Key words:** hepatoduodenal ligament, Calot's triangle, cystic artery syndrome

## INTRODUCTION

Knowledge of cystic artery variability facilitates intraoperative identification of vessels in both classical and laparoscopic surgery of the bile ducts [4]. The various origins of the cystic artery and its course with respect to the hepato-biliary triangle (Calot's triangle) require the attention of surgeons in order to avoid iatrogenic injury of the bile ducts and vessels [4, 10, 11, 15]. Recognition of the vasculature of the gallbladder in human fetuses was assumed in the present study. The purpose of the investigation was to determine the origin of the cystic artery origin and its relation to Calot's triangle.

## MATERIAL AND METHODS

The material examined comprised 34 human fetuses, aged from 13 to 32 weeks of intrauterine life, from the collection of Department of Normal Anatomy in Bydgoszcz. Foetus age was specified on the basis of vertex-tuberal (V-T) and vertex-plantar (V-P) diameters on the strength of Scammon and Calkins' tables. The arterial bed of the fetuses was injected with white latex LBS 3060 and the specimens were fixed in 10% formalin solution. The abdominal cavity was opened by a middle and transverse cut in the epigastrium. The gall bladder and its arteries were exposed and documented by means of a digital camera Nikon Coolpix 950.

**Table 1.** Morphological characteristics of cystic artery

No.	Origin	Number		Relation to Calot's triangle	Relation to bill ducts	Type of cystic artery trunk
1	Right branch of proper hepatic artery	12	35.29%	Within triangle	Behind common hepatic duct	Short type
		7	20.59%			Long type
		1	2.94%		Double	
		6	17.64%		Over common hepatic duct	Short type
		2	5.88%		Long type	
2	Left branch of proper hepatic artery	2	5.88%	Over common hepatic duct	Long type	
3	Proper hepatic artery	3	8.82%	Behind common hepatic duct	Long type	
4	Gastroduodenal artery	1	2.94%	Out of triangle	At the left of cystic duct	Long type
		34	100.00%			

## RESULTS

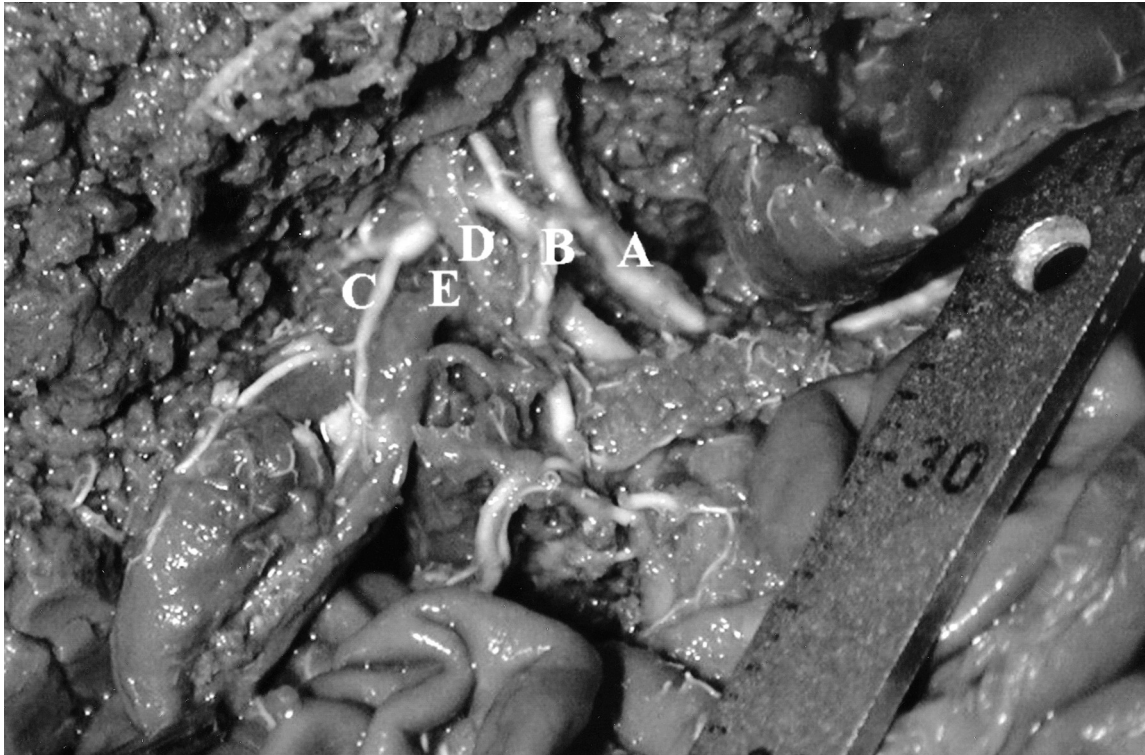
The collated table shows the morphological characteristics of the cystic artery with regard to its origin, its relation to Calot's triangle and the bile ducts and the nature of its trunk (Table 1). The cystic artery was most often (97.06%) a single vessel (Fig. 1) and only in one case (2.94%) was it a double vessel (Fig. 2). It arose most often (82.34%) from right proper hepatic artery, rarely from its trunk (8.82%) or its left branch (5.88%) and most rarely (2.94%) from the gastroduodenal artery. In all but one case the cystic artery coursed within Calot's triangle. Its exceptional course out of Calot's triangle concerned a cystic artery originating from the gastroduodenal artery (2.94%). The cystic artery most frequently (67.66%) runs behind the common hepatic duct, rarely (29.40%) over common the hepatic duct and most rarely (2.94%) on the left side of the cystic duct. In the material examined the cystic artery was not observed running in front of the common hepatic duct. The short type of cystic artery trunk (52.93%) was observed more frequently than the long one (44.13%).

## DISCUSSION

On the basis of anatomical examinations there has been observable development in laparoscopic surgery of the bile ducts [17] as well as interventional radiology of the visceral arteries (selective angiography and endovascular embolisation of the arteries) [12, 18], which have significantly complemented the anatomical data previously obtained for clinical needs. Our investigations have shown that the cystic artery was a single vessel in as much as 97.96%

of cases. This fact corresponds with Osemlak's and Siwek's result [14] of 99.26%. Suzuki et al. [17] observed a double cystic artery in laparoscopic material in 11.1% of cases, and Balija et al. [1] as in as many as 21.1%, with one case (0.1%) of a triple cystic artery. Bergamaschi found two cystic arteries in a 4% corrosion cast of human cadavers [2, 3].

In the present work we observed that the cystic artery most often (82.34%) originated from the right branch of the proper hepatic artery, which is confirmed by the results of Osemlak and Siwek [14] — 83.7%, Chen et al. [5] — 86.1% and Futara et al. [7] — 75.5%. The origin of the cystic artery from the trunk of the proper hepatic artery, observed in this research in 8.82%, was also found by Osemlak and Siwek [14] in 8.15%. Derivation of the cystic artery from the left branch of the proper hepatic artery (5.88%) and from the gastroduodenal artery (2.94%) was rarely observed in our material. The origin of the cystic artery from left branch of the proper hepatic artery was described by Osemlak and Siwek [14] in 0.74% and Futara et al. [7] in 1.8% of cases. The gastroduodenal artery was a source of the cystic artery from 0.74% [14] to 7.3% [7]. It should be emphasised that the origin of the cystic artery from the gastroduodenal artery both in our results and in those of Sarkar and Roy [16] involved its long trunk running out of Calot's triangle along the left side of the cystic duct. Furthermore, Osemlak and Siwek [14] described the origin of the cystic artery from the artery of the medial (5.92%) and anterior (0.74%) hepatic segment, and Komatsu et al. [12] from hepatic segment V, which has special clinical significance for



**Figure 1.** Single cystic artery within Calot`s triangle behind the common hepatic duct (short type); A — common hepatic artery, B — gastroduodenal artery, C — cystic artery, D — common bile duct, E — cystic duct.



**Figure 2.** Double cystic artery within Calot`s triangle; A — common hepatic artery, B — right hepatic artery, C — cystic duct, D — "double" cystic artery.

the transcatheter arterial embolisation of hepatic neoplasms. Duric et al. [6] found lateral branches of the cystic artery which supplied a part of the anteromedial segment of the right liver lobe in 10% of cases. In 12% he observed anastomotic bridges between the cystic artery and the arterial system of the liver [2, 6, 18].

These special arterial branching patterns might be a source of arterial bleeding during or after laparoscopic cholecystectomy. On the basis of 1,000 laparoscopic cholecystotomies Baliija et al. [1] distinguished two groups of cystic artery types. The first group included as many as 5 vascular pictures of the cystic artery within Calot's triangle: a) "normal" position (47.3%), b) frontal cystic artery (11.5%), c) rear (2.7%), d) multiple (double — 21.1%, triple — 0.1%) and e) a short cystic artery that arises from an aberrant right hepatic artery (5.3%). The second group concerned variations of the cystic artery that approach the gallbladder beyond Calot's triangle and was made up of 3 vascular images: the "low-lying" (11.2%), the transhepatic (0.3%) and the "recurrent" (0.2%). Also on the basis of laparoscopic material, Suzuki [16] classified cystic arteries into 3 groups. In the first group the gallbladder artery ran within Calot's triangle as a single (76.6%) or double (2.5%) vessel. In 2.5% of cases a single cystic artery encompassed a cystic duct, making bile outflow difficult, so-called "cystic artery syndrome". In the second group a proper cystic artery ran within Calot's triangle and an accessory cystic artery ran out of it. In the third group cystic arteries ran out of Calot's triangle. The cystic artery within Calot's triangle was observed in our material in as many as 97.06% of cases, thus slightly more often than in the literature 80–96% [1, 5, 7, 9, 17]. Most often (67.66%) the cystic artery ran behind the common hepatic duct, more frequently than indicated by Baliija's et al. results [1] — 58.8%, and more rarely than indicated by those of Gadzijev [8] — 80%, and Chen et al. [5] — 72.7%. In a few cases there was a third structure within Calot's triangle. Bergamaschi's et al. study [3] indicated early division of the right hepatic artery in 36% of cases, a liver branch of the cystic artery in 10% and in 5.75% a double cystic artery. Idu et al. [10] in 6 cases of left-side location of the gall bladder observed that the cystic artery always crossed the common bile duct in front of it.

Knowledge of this variable anatomy of Calot's triangle is particularly important during surgical interventions in which preoperative imaging studies are not available [13].

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