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ORIGINAL RESEARCH

Anatomic variations of the cystic artery in a Colombian cadaveric series

Variantes anatómicas de la arteria cística en una serie cadavérica colombiana

Yobany Quijano-Blanco[1,2] Ivan Camilo Muñoz-Castaño[1]

[1] Universidad de Ciencias Aplicadas y Ambientales U.D.C.A - Faculty of Health Sciences - Medical Program - Bogotá D.C - Colombia.
[2] Universidad Nacional de Colombia - Bogotá Campus - Faculty of Medicine - Department of Morphology - Bogotá D.C. - Colombia.

Abstract

Introduction: Compared to other countries, studies on the anatomical characteristics of the cystic artery in the Colombian population are scarce.
Objective: To describe the anatomical characteristics of the cystic artery in a sample of 60 cadaveric specimens from Colombia.
Materials and methods: Descriptive study conducted between 2021 and 2023. The cystic artery from 60 digestive tracts of cadaveric specimens with no history of biliary tract disease or surgery was dissected. A macroscopic examination of the cystic artery was performed, and information on its origin, anatomical shape, length, diameter, general anatomical distribution, distribution in relation to the gallbladder, and distribution in relation to the right and left hepatic ducts was recorded.
Results: In 95%, 98.33%, and 66.67% of digestive systems, the cystic artery originated in the right hepatic artery, had a linear shape, and extended through the cystohepatic triangle, respectively. Moreover, its mean length and diameter were 15.90±7.36 mm (maximum: 54.10 mm; minimum: 4 mm) and 1.64±2.30 mm (maximum: 9.60; minimum: 2.20 mm), respectively.
Conclusions: The characteristics of the cystic artery in a cadaveric sample from the Colombian population are similar to those reported in other countries in terms of origin and length; however, the diameter is smaller.

Resumen

Introducción. En comparación con otros países, los estudios sobre las características anatómicas de la arteria cística en población colombiana son escasos.
Objetivo. Describir las características anatómicas de la arteria cística en una muestra de 60 cadáveres de Colombia.
Materiales y métodos. Estudio descriptivo realizado entre 2021 y 2023. Se disecó la arteria cística de 60 aparatos digestivos de cadáveres sin antecedentes de enfermedades o cirugía de las vías biliares. Mediante el examen macroscópico de la arteria cística se registró información sobre su origen, forma anatómica, longitud, diámetro, distribución anatómica general, distribución con respecto a la vesícula biliar y distribución con respecto a los conductos hepáticos derecho e izquierdo.
Resultados. En 95%, 98.33% y 66.67% de los aparatos digestivos la arteria cística se originó en la arteria hepática derecha, tuvo una forma lineal y se extendió a través del triángulo hepatocístico, respectivamente. Además, la longitud y el diámetro promedios fueron 15.90±7.36mm (máximo: 54.10mm; mínimo: 4mm) y 1.64±2.30mm (máximo:9.60; mínimo: 2.20mm).
Conclusiones. Las características de la arteria cística en una muestra cadavérica de población colombiana son similares a las reportadas en otros países en términos de origen y longitud; sin embargo, el diámetro es inferior.

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Corresponding author: Yobany Quijano-Blanco. Departamento de Morfología, Facultad de Medicina, Universidad Nacional de Colombia. Bogotá D.C. Colombia. E-mail: yquijanob@unal.edu.co.

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Palabras clave: Anatomía; Arteria Hepática; Enfermedades de las Vías Biliares; Disección; Variación Anatómica (DeCS).

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Introduction

The cystic artery (CA) is the main artery supplying the gallbladder and the cystic duct. In most cases (70-80%), it originates from the right hepatic artery to the right of the common hepatic duct in the cystohepatic triangle (Budde-Rocko triangle).[1-4] Starting from its origin, the CA usually courses posterolateral to the common hepatic duct and anterior to the cystic duct towards the neck of the gallbladder, where it divides into two branches: superficial and deep. The superficial branch supplies the lower portion of the gallbladder, while the deep branch supplies the upper portion.[3,5] Furthermore, various fine branches (two to four) derive from the CA and supply the common hepatic duct, the cystic duct, and the proximal part of the common bile duct (choledochus).[4,5]

The treatment of biliary tract diseases, such as cholelithiasis, cholecystitis, cholangitis, and biliary obstruction, involves surgery (i.e., open or laparoscopic cholecystectomy). Therefore, knowing the anatomy of the CA and its variations is essential to reduce the risk of iatrogenic injuries and other complications —such as destruction of the vesicular wall and bile duct, and, especially, bleeding secondary to CA injury—[1,3,6-9] as well as to achieve adequate surgical outcomes.[9-11] Consequently, surgeons performing these procedures must be familiar with the typical anatomy and anatomical variations of the CA.

According to Li *et al.*,[12] in 2019, there were 52 003 772 incident cases of biliary diseases worldwide, with an age-standardized incidence rate (ASIR) of 634.32 per 100 000 population, and 193 493 378 prevalent cases of gallbladder disease, with an estimated age-standardized prevalence rate of 2 350.78 per 100 000 inhabitants. Meanwhile, in tropical Latin America, there were 2 540 250 (ASIR: 1 041) and 9 474 074 (ASIR: 3 805.6) cases for both sexes, respectively. In Colombia, a literature search shows that there are no studies reporting epidemiological data for this group of diseases. However, there are data for specific diseases such as acute cholecystitis, which had an unadjusted prevalence of 681 cases per 100 000 inhabitants for the period 2018-2022.[13]

There are no studies on the anatomical characteristics of the CA in the Colombian population. Thus, the objective of this study was to describe the anatomical characteristics of the CA in a sample of 60 cadaveric specimens from Colombia.

Materials and methods

Study type

Descriptive study of a cadaveric series.

Sample

Sixty complete digestive systems (liver, extrahepatic bile ducts, pancreas, and small and large intestines) were analyzed. They were preserved in Chilean conservative fixative solution (2% formaldehyde, glycerin, benzalkonium chloride, methyl alcohol, sodium chloride, eucalyptus oil, urea, and water). The digestive tracts were extracted from cadavers in the anatomy laboratory belonging to the medical program at the Universidad de Ciencias Aplicadas y Ambientales - U.D.C.A. (Bogotá, Colombia). Digestive tracts in poor condition, with evidence of trauma, or from cadavers with a reported history of disease or biliary tract surgery were not considered eligible. Cadavers were included through purposive sampling based on eligibility criteria.

Procedures and variables

Once the digestive tract was preserved in Chilean conservative fixative solution, the cystohepatic triangle was detected, identifying the cystic duct, the lower edge of the liver, and the common hepatic duct. The peritoneum and omentum were removed, and the CA was isolated. During and after anatomical isolation or delimitation, a macroscopic examination was performed to collect the following anatomical information about the CA: origin, anatomical shape, length, diameter, general anatomical distribution, distribution in relation to the right hepatic duct (RHD) and left hepatic duct (LHD), and distribution in relation to the gallbladder. In order to systematize the information, the tracts were numbered (1 to 60). Also, a photographic record of each block was taken.

These procedures were performed by the two researchers between 2021 and 2023. Moreover, it should be noted that the length and diameter of the CA were measured using a digital vernier caliper: length was measured by placing one end of the caliper at the origin of the CA, which was usually found in the right hepatic artery, and the other end at the neck of the gallbladder, while diameter was measured in the middle portion of the CA's path, without sectioning the blood vessel.

Statistical analysis

Data are described using absolute frequencies and percentages for categorical variables and means and standard deviations for quantitative variables since a normal distribution was observed (Kolmogorov Smirnov test). Variance and coefficient of variation were also calculated for the length and diameter variables. The information was recorded in a database created in Microsoft Excel 2019 for subsequent analysis in the EPIDAT 4.2 software (version 4.2).

Ethical considerations

This study followed the provisions of Decree 786 of 1990 issued by the Colombian Ministry of Public Health, now the Ministry of Health and Social Protection, on how to perform clinical and medico-legal autopsies,[14] as well as the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki,[15] ensuring at all times a respectful treatment of the bodies and guaranteeing the confidentiality of their data, their dignity, and their integrity. Furthermore, the provisions of Chapter VI (on research involving organs, tissues and their derivatives, products, and human cadavers) of Resolution 8430 of 1993 issued by the Colombian Ministry of Social Protection and Health were taken into account.[16] Finally, the study was approved by the Ethics Committee of the Faculty of Health Sciences of the Universidad U.D.C.A. through minutes No. 135 of February 27, 2021.

Results

The CA originated in the right hepatic artery in 95% (n=57) of the cadavers, while the remaining 5% (n=3; blocks 7, 18, and 26) originated in the superior mesenteric artery (Figure 1 and Table 1).

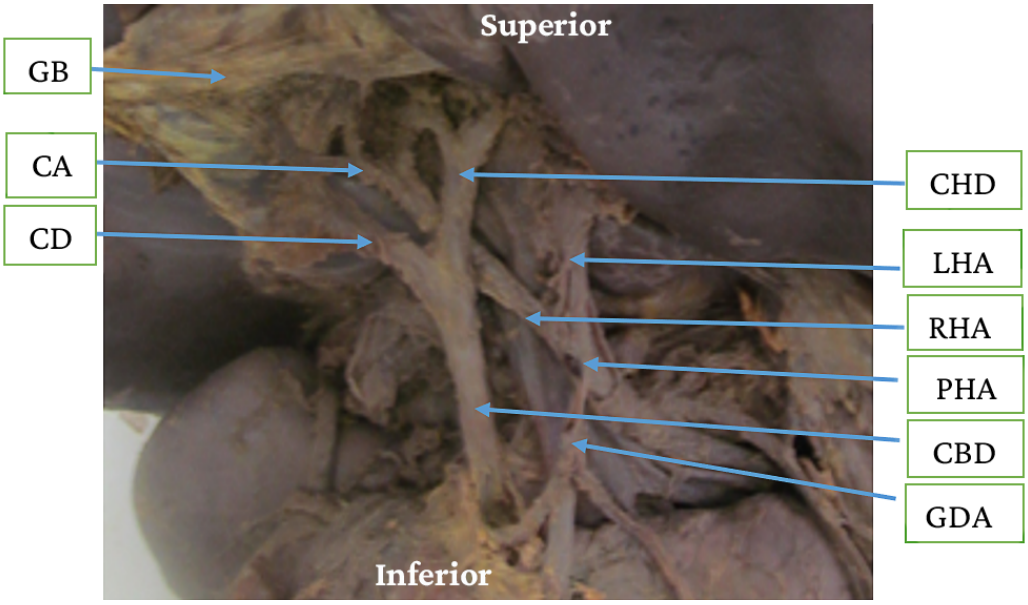

Figure 1. Origin of the cystic artery in the right hepatic artery.
GB: gallbladder; CA: cystic artery; CD: cystic duct; CHD: common hepatic duct; LHA: left hepatic artery; RHA: right hepatic artery; PHA: proper hepatic artery; CBD: common bile duct; GDA: gastroduodenal artery.

Table 1. Morphometric characteristics and distribution of the cystic artery in digestive blocks from adult Colombian cadavers (n=60).

Block/Digestive tract		Origin of the CA	CA shape	Anatomical distribution in relation to the GB	Length of the CA (mm)	Diameter of the CA (mm)
1		A. Right Hepatic	Y	Anterior	11.10	1.10
2		A. Right Hepatic	Lineal	Anterior	13	1.10
3		A. Right Hepatic	Lineal	**Anterior-Posterior**	13.40	2.50
4		A. Right Hepatic	Lineal	Anterior	13.90	1.90
5		A. Right Hepatic	Lineal	**Anterior-Posterior**	23.30	1.60
6		A. Right Hepatic	Lineal	Anterior	10.90	2.10
7		A. Superior mesenteric	Lineal	Anterior	10.70	1.10
8		A. Right Hepatic	Lineal	**Anterior-Posterior**	18.80	1.70
9		A. Right Hepatic	Lineal	Anterior	6.90	0.80
10		A. Right Hepatic	Lineal	**Anterior-Posterior**	33.30	1.90
11		A. Right Hepatic	Lineal	**Anterior-Posterior**	10	0.90
12		A. Right Hepatic	Lineal	Anterior	19.60	0.90
13		A. Right Hepatic	Lineal	Anterior	19.90	0.90
14		A. Right Hepatic	Lineal	Anterior	13.60	2.10
15		A. Right Hepatic	Lineal	**Anterior-Posterior**	18.90	1.70
16		A. Right Hepatic	Lineal	Anterior	8	0.20
17		A. Right Hepatic	Lineal	Anterior	4	0.80
18		A. Superior mesenteric	Lineal	Anterior	7.10	1.50
19*	A	A. Right Hepatic	Lineal	Anterior	9.10	9.60
	B	A. Right Hepatic	Lineal	Posterior	18.90	1.40
20		A. Right Hepatic	Lineal	**Anterior-Posterior**	13	0.90
21		A. Right Hepatic	Lineal	Anterior	10.90	0.90

Table 1. Morphometric characteristics and distribution of the cystic artery in digestive blocks from adult Colombian cadavers (n=60). (Continued)

Block/Digestive tract	Origin of the CA	CA shape	Anatomical distribution in relation to the GB	Length of the CA (mm)	Diameter of the CA (mm)
22	A. Right Hepatic	Lineal	**Anterior-Posterior**	26.50	1.20
23	A. Right Hepatic	Lineal	Anterior	11.10	1.30
24	A. Right Hepatic	Lineal	Anterior	23.90	3.20
25	A. Right Hepatic	Lineal	Anterior	17.20	1.40
26	A. Superior mesenteric	Lineal	**Posterior**	54.10	3
27	A. Right Hepatic	Lineal	Anterior	8.80	1
28	A. Right Hepatic	Lineal	Anterior	18.20	1.10
29	A. Right Hepatic	Lineal	Anterior	21.40	1
30	A. Right Hepatic	Lineal	Anterior	22.30	0.90
31	A. Right Hepatic	Lineal	Anterior	19.20	1.20
32	A. Right Hepatic	Lineal	Anterior	13.70	1.20
33	A. Right Hepatic	Lineal	Anterior	18.60	1
34	A. Right Hepatic	Lineal	Anterior	16.10	1
35	A. Right Hepatic	Lineal	Anterior	12	1.10
36	A. Right Hepatic	Lineal	Anterior	12	1.10
37	A. Right Hepatic	Lineal	Anterior	13.20	1.30
38	A. Right Hepatic	Lineal	Anterior	12.30	1.20
39	A. Right Hepatic	Lineal	Anterior	14.50	1.30
40	A. Right Hepatic	Lineal	Anterior	12.50	1.60
41	A. Right Hepatic	Lineal	Anterior	14.30	1.20
42	A. Right Hepatic	Lineal	Anterior	14.30	1.20
43	A. Right Hepatic	Lineal	Anterior	26	2.30
44	A. Right Hepatic	Lineal	Anterior	17.80	1.20
45	A. Right Hepatic	Lineal	Anterior	10.40	1.20
46	A. Right Hepatic	Lineal	Anterior	13.80	1.30
47	A. Right Hepatic	Lineal	Anterior	11.10	1.10
48	A. Right Hepatic	Lineal	Anterior	15.40	0.80
49	A. Right Hepatic	Lineal	Anterior	11.80	1.20
50	A. Right Hepatic	Lineal	Anterior	20.70	1.40
51	A. Right Hepatic	Lineal	Anterior	13.90	1.10
52	A. Right Hepatic	Lineal	Anterior	21.60	1.20
53	A. Right Hepatic	Lineal	Anterior	14.20	1.10
54	A. Right Hepatic	Lineal	Anterior	11.80	1.10
55	A. Right Hepatic	Lineal	Anterior	18.30	2.40
56	A. Right Hepatic	Lineal	Anterior	23.70	1.60
57	A. Right Hepatic	Lineal	Anterior	20.10	1.50
58	A. Right Hepatic	Lineal	Anterior	14.30	1.10
59	A. Right Hepatic	Lineal	Anterior	17.90	1.70
60	A. Right Hepatic	Lineal	Anterior	13.90	1.90

CA: cystic artery; GB: gallbladder; A: anterior; B: posterior.
* This digestive block had two cystic arteries, so the information for each one (A and B) was systematized.

In terms of anatomical shape, in 98.33% (n=59) of digestive tracts, the CA had a linear shape (i.e., artery without bifurcations), while in the remaining 1.67% (n=1; digestive block number 1), it had a Y-shape (Table 1) (Figure 2C), with a common trunk from the

geniculate angle (point of angulation prior to its anatomical bifurcation, near the neck of the gallbladder) and a bifurcation approximately 4 mm from its origin.

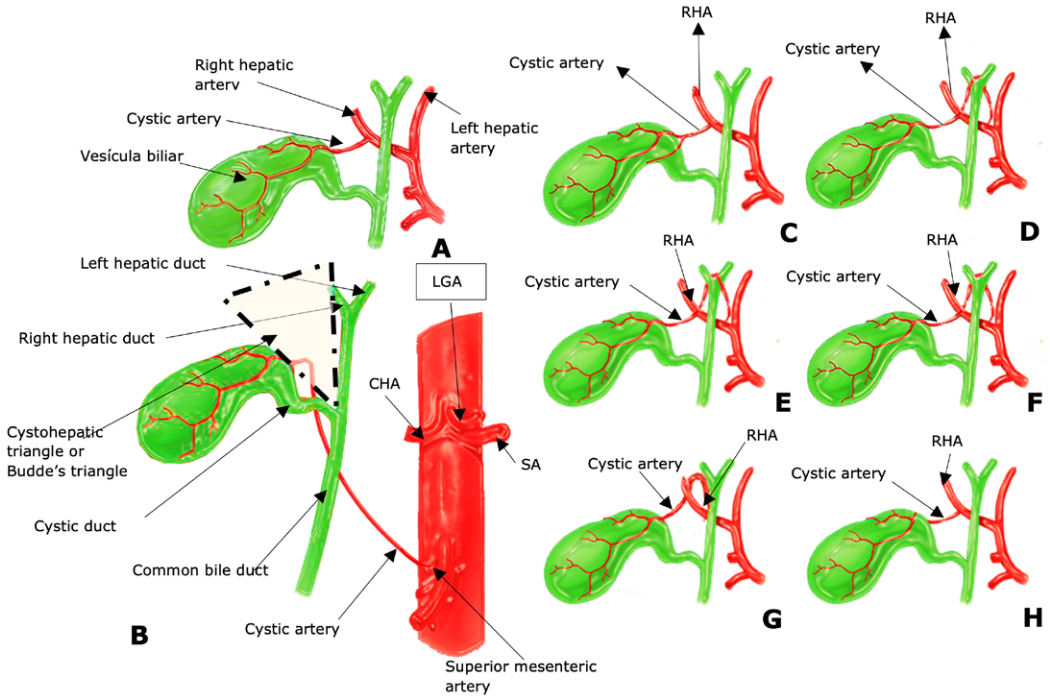

Figure 2. Illustration of the common origin of the cystic artery, documented anatomical variations, and their relationship to the structures of the biliary tract. A) Linear cystic artery originating from the right hepatic artery and reaching the gallbladder anteriorly; B) Cystic artery originating from the superior mesenteric artery; C) Y-shaped cystic artery upon reaching the neck of the gallbladder; D) Cystic artery that runs anterior to the right hepatic duct; E) Cystic artery that runs posterior to the right hepatic duct; F) Cystic artery that runs posterior to the right and left hepatic ducts; G) Cystic artery running to the right of the right hepatic duct; H) Cystic artery that reaches the gallbladder posteriorly.
CHA: common hepatic artery; RHA: right hepatic artery; SA: splenic artery; LGA: left gastric artery.

With regard to the general anatomical distribution of the CA, it passed directly through the cystohepatic triangle to the neck of the gallbladder in 66.67% (n=40) of digestive tracts, and it coursed through the anterior surface and posterior surface of the common hepatic duct in 21.67% (n=13) and 11.66% (n=7) of cases, respectively.

Concerning the distribution of the CA with respect to the RHD and LHD, it was found that it passed anterior to the RHD in 5% (n=3) of the cadavers, posterior to the RHD in 1.67% (n=1), and anterior to both the RHD and LHD simultaneously in 3.21% (n=2). In the remaining 90.12%, the CA coursed to the right of the RHD (Figures 2D, 2E, and 2F).

As for its distribution in relation to the gallbladder, the CA exhibited anterior, posterior, and both anterior and posterior distribution in 83.33% (n=50), 1.67% (n=1; specimen 26), and 15% (n=9) of the cadavers, respectively (Figures 2A and 2H).

The mean length of the CA was 15.93±7.36 mm, with a minimum length of 4 mm (specimen 17) and a maximum length of 54.10 mm (specimen 26) (Table 1), for a variance of 54.23 mm with a coefficient of variation of 0.46. The mean diameter was 1.64±2.30 mm, with a minimum diameter of 0.20 mm (specimen 16) and a maximum diameter of 9.60 mm (branch A of block 19), for a variance of 5.32 mm with a coefficient of variation of 1.39.

Other noteworthy findings include: i) the CA, in all digestive tracts with aberrant CA origin (superior mesenteric artery; n=3), had a linear shape and showed an anterior

distribution with respect to the gallbladder; ii) all arteries with posterior (n=1) and anterior (n=50) anatomical distribution in relation to the gallbladder originated from the right hepatic artery; iii) the longest digestive tract (specimen 26) was the only one that was located posterior to the gallbladder; and iv) only one cadaveric specimen (specimen 19) had two CAs (branches A and B) (Table 1), which had the same characteristics in terms of origin, shape, and distribution with respect to the gallbladder, although they had different lengths and diameters; in fact, branch A was the CA with the largest diameter in the sample.

Discussion

This study describes variations in the CA in terms of its origin, anatomical shape, length, diameter, general anatomical distribution, and distribution in relation to the gallbladder, RHD, and LHD in a sample of Colombian cadavers. Knowing the anatomical variations of this artery allows for better outcomes in surgical procedures on the bile ducts, such as laparoscopic cholecystectomy,[2,3,8-12] and therefore the findings reported here are of great importance for surgeons performing these procedures in the country.

The present study found that the CA originated in the right hepatic artery in 95% of cadavers, which is consistent with similar international studies reporting that the frequency of the CA originating in this location ranges from 90% to 94.40%.[17-23] However, this figure is higher than the one reported by Triantafyllou *et al.,*[24] who conducted a systematic review with meta-analysis that included 68 studies reporting data on the characteristics of the CA, namely its origin, number, relationship with the cystohepatic triangle, relationship with various ducts, and morphometric measurements, finding that the artery originated in the right hepatic artery in 85.75% of cases. It is also higher than the frequency reported in studies conducted in the region, such as the study carried out in Venezuela by Antonetti & Diaz[25] on 82 fetal bile ducts, in which 58.5% of the CAs originated in the right hepatic artery, or the study conducted in Argentina by Algieri *et al.*[26] in 458 post-surgical patients at the Hospital Aeronáutico Central in Buenos Aires and in 12 cadavers from the anatomy laboratory of the Universidad de Buenos Aires, in which this artery originated in the right hepatic artery in 75% of cases. This discrepancy with the study carried out by Algieri *et al.*[26] could be explained by differences in sample size (60 cadavers vs. 460 surgical patients and cadavers), whereas the Antonetti & Díaz[25] study could be more related to the type of population (adult corpses vs. fetuses). It should be noted that studies on this topic in the region are scarce and for this reason the study by Antonetti & Diaz[25] is included for comparison purposes.

The CA can also originate in the left hepatic artery, the common hepatic artery, the proper hepatic artery, the gastroduodenal artery, the superior mesenteric artery, the celiac trunk, or the aorta.[3,24,27-30] In this study, the CA originated in the superior mesenteric artery in the remaining 5% of cadavers. This finding is similar to that found in Chile by Castro *et al.,*[31] who also reported that this was the origin in 5% of patients in a study that examined hepatic arterial circulation using multislice computed tomography in 100 patients. However, it is higher than what was reported by Triantafyllou *et al.*,[24] who found that the combined prevalence of cystic CA originating in the superior mesenteric artery was only 1.25%.

Table 2 presents the findings regarding the origin of the CA reported in several international studies.

Table 2. Comparison of cystic artery origin variation with studies conducted worldwide in different populations.

Study	Number of cases	Type of population	Origin of the cystic artery (%)													
			GDA	AHA	CHA	RHA	AB-RHA	LHA	MHA	PHA	SMA	SPDA	LGA	RGA	AAA	CT
Tejaswi *et al.*[17] (2013)	100	Cadavers - India	1	-	-	92	4	1	-	2	-	-	-	-	-	-
Nayak & Vasudeva[32] (2013)	1	Cadaver - India	2	-	26	63	-	5	-	-	-	-	-	-	-	-
Ramakrishna & Tiwari[18] (2019)	50	Cadavers - India	2	-	-	92	4	2	-	-	-	-	-	-	-	-
Pushpalatha & Shamasundar[33] (2010)	50	35 cadavers and 15 fresh post-mortem specimens	8	2	12	54	-	-	-	22	2	-	-	-	-	-
Daseler *et al.*[34] (1947)	580	Cadavers for dissection - Chicago, United States	2.60	-	2.70	71.70	16	6.20	-	-	0.10	-	-	-	-	0.35
Sonali *et al.*[35] (2016) (35)	40	Cadavers - India	10	-	-	70	-	5	-	7.50	5	-	-	2.50	-	-
kumari *et al.*[19] (2016)	36	Cadavers - India	-	-	-	94.40	-	-	-	2.78	-	-	-	-	2.78	-
Dandekar & Dandekar[3] (2016)	82	Cadavers - India	-	-	2.50	79.30	12.10	1.20	1.20	3.70	-	-	-	-	-	-
Michels[36] (1951) (36)	200	Cadavers - Philadelphia, United States	4	-	1.5	77.5	12	5	-	-	-	-	-	-	-	-
Saidi *et al.*[20] (2007)	102	Cadavers - Kenya, Arica	-	-	-	93.14	-	1.96	-	4.90	-	-	-	-	-	-
Bakheit[37] (2009)	160	Cadavers - Sudan, Africa	3	-	17	78	-	2	-	-	-	-	-	-	-	-
Khalil *et al.*[21] (2008)	60	Cadavers - India	2	-	3	90	-	3	-	2	-	-	-	-	-	-
Donderis de Carrión[30] (2007)	62	Cadavers- Panama	1.60	-	-	95.20	-	-	-	3.2	-	-	-	-	-	-
Pradhan *et al.*[22] (2022)	30	Cadavers - Nepal	-	3.30	-	90	-	-	-	3.30	3.30	-	-	-	-	-
Coello-Cuntó *et al.*[11] (2019)	30	Female patients in the preoperative period - Ecuador	3.33	-	3.33	73.33	10	6.67	-	3.33	-	-	-	-	-	-
Andall *et al.*[2] (2015)	9836	Systematic review of arteriography reports and cadavers	1.94	2.51	1.10	79.02	5.58	2.10	-	2.55	0.29	0.07	-	1.94	-	0.10
Antonetti & Diaz[25] (2007)	82	Human fetuses for radiology and dissection - Venezuela	-	-	-	58.54	9.75	-	-	-	-	-	-	-	-	-
Algieri *et al.*[26] (2014)	458	458 surgical patients - 12 cadavers / Buenos Aires, Argentina	-	-	-	75	-	16.66	-	8.34	-	-	-	-	-	-
Gawali[23] (2014)	30	Cadavers, Kathmandu, Nepal	3.30	-	-	90	3.30	3.30	-	-	-	-	-	-	-	-
This study	60	Cadavers - Bogotá, Colombia	-	-	-	95	-	-	-	-	5	-	-	-	-	-

GDA: gastroduodenal artery; AHA: accessory hepatic artery; CHA: common hepatic artery; RHA: right hepatic artery; AB-RHA: aberrant right hepatic artery; LHA: left hepatic artery; MHA: middle hepatic artery; PHA: proper hepatic artery; SMA: superior mesenteric artery; SPDA: superior pancreatoduodenal artery; LGA: left gastric artery; RGA: right gastric artery; AAA: abdominal aorta artery; CT: celiac trunk.

In relation to the general anatomical distribution, the CA passed directly through the cystohepatic triangle to reach the neck of the gallbladder in 66.67% of digestive tracts, while it coursed along the anterior surface and posterior surface of the common hepatic duct in 21.67% and 11.66% of cases, respectively. This finding is similar to that reported in the study by Suzuki *et al.*,[38] conducted in Japan on a sample of 244 patients who underwent cholecystectomy, in which a higher percentage (76.60%) of the CAs were found to course into the cystohepatic triangle, and in the systematic review of Triantafyllou *et al.*,[24] in which the CA was located mainly inside the cystohepatic triangle, with a pooled prevalence of 83.83%. Furthermore, the findings of this study are contrary to those reported by

Andall[2] in a systematic review of cystic artery variations that included 9 800 cases, which found that 485 (17.90%) of 2 704 CAs were located inferior to the common hepatic duct.

On the other hand, there was only one case of double CA (1.67%). Although this anatomical variation is atypical, the frequency of this finding in the present study is lower than that reported in the region. For example, Donderis de Carrión,[30] in a study carried out on 62 cadavers in Panama, found 4 cases (6.45%) of double CA, while Triantafyllou *et al.*,[24] in their systematic review, found that double CA had a pooled prevalence of 8.59%. The variability in the number of CAs should be considered because, as some authors point out, laparoscopic visualization differs from the one achieved in an open procedure for the management of biliary tract diseases. Therefore, knowing and taking into account the variations in the CA and its branches allows preventing bleeding and reducing the risk of iatrogenic injuries and other complications, such as destruction of the vesicular wall and bile duct.[9-11]

In the present study, the mean length of the CA was 15.9±7.36 mm. This finding is in agreement with similar studies conducted in India and Nepal, where this value ranged from 16.90 mm to 17.90 mm.[3,17-19,22] However, this figure is lower than the one reported by Triantafyllou *et al.*,[24] who found in their systematic review that the pooled mean length of the CA was 21.34 mm.

The mean diameter was 1.64±2.30 mm (Table 3), a figure similar to that reported in India by Dandekar and Dandekar[3] (mean: 1.60), but lower than those reported by Pradhan[22] (mean: 2 mm), Gür Özcan *et al.*[39] (mean: 1.90), and Alharbi[40] (mean: 2) in India, Turkey, and Saudi Arabia, respectively (Table 3). Although we did not find any studies providing data on the length and diameter of this artery in Colombia or the region, the study conducted by Donderis de Carrión[30] (in Panama) found that the diameter ranged between 2 mm and 2.50 mm in 79% of the cadavers, so it is possible to infer that the average diameter in that study is greater than what was found in our cadavers. The heterogeneity of this parameter between studies, as well as the lack of data in many countries, makes it clear that studies analyzing the diameter of the CA in different populations are needed, as it has been reported that this variable may be useful for the diagnosis of acute cholecystitis with a cutoff point <1.9 mm on CT scans (AUC: 0.852, sensitivity: 94%, specificity: 75-5, p<0.001, 95%CI: 0.792-0.899).[39]

Table 3. Comparison of cystic artery diameter and length with various studies.

Study	Number of cases	MAX. D. (mm)	MIN. D. (mm)	SD (mm)	M.D.	MIN. L. (mm)	MAX. L. (mm)	SD (mm)	M.L.
Gür Özcan *et al.*[39] (2024)	187	2.35		0.42	1.90	-	-	-	-
Tejaswi *et al.*[17] (2013)	100	-	-	-	-	3.70	42	0.56	17.60
Ramakrishna & Tiwari[18] (2019)	50	3.20	1.10	-	2.20	3.50	42	-	17.60
Dandekar & Dandekar[3] (2016)	82	5	1	-	1.60	2	55	-	16.90
Donderis de Carrión[30] (2007)	62	2.50	2	-	-	-	-	-	-
Pradhan *et al.*[22] (2022)	30	-	-	-	-	3.70	42	3.64	17.60
Alharbi[40] (2022)	1	-	-	-	2	-	-	-	17
Presente estudio	60	9.60	2.20	2.30	1.64	4	54.10	7.36	15.90

D: diameter; L: length; MAX: maximum; MIN: minimum; M: mean; SD: standard deviation.

The limitations of this study include the fact that the health crisis caused by the COVID-19 pandemic considerably prolonged data collection and the consolidation of results. However, given the number of cadavers analyzed, the data presented here will be of use to surgeons involved in the surgical treatment of biliary tract diseases in the Colombian population.

Conclusions

The anatomical characteristics of the CA in the Colombian cadaver sample studied are similar to those described in the international literature in terms of origin and length, but the mean diameter was generally smaller than what has been reported in other countries. However, it is evident that the literature on this subject is scarce worldwide, so further studies are required to understand the anatomy and anatomical variants of this artery in surgical procedures involving the bile ducts.

Conflicts of interest

None stated by the authors.

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