Original Research Article

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Incidence of double cystic artery: a clinical study

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ABSTRACT

Background: A successful laparoscopic cholecystectomy is associated with the knowledge about anatomic structures and the congenital anomaly of the biliary tract. The aim of this study was to become familiar with vascular variations in laparoscopic cholecystectomy.

Methods: This was a retrospective clinical study. The files of patients who underwent laparoscopic cholecystectomy due to benign gallbladder diseases were analyzed. The characteristics and complications of the patients with double cystic artery were recorded and examined.

Results: A total of 360 patients, 76 males and 284 females were included in the study. The mean age was 51.2 (25-81). When the files of the patients were examined, it was found that double cystic arteries were detected during the operation in two male (2.63%) and nine female patients (3.16%). Gall bladder polyp was found as an indication for operation in one of 11 patients, while multiple gallbladder stones were found as an indication for operation in the other patients. The laparoscopic cholecystectomy was converted to conventional cholecystectomy in two from 11 patients (18.1%) with double cystic arteries due to bleeding. The mean duration of hospital stay in the patients with double cystic artery is 5.2 (3-11) days, and (2.7 days) longer compared to the patients without a double cystic artery.

Conclusions: Cystic artery variations and other variations can coexist. Awareness of cystic artery variations can reduce the possibility of uncontrolled intraoperative bleeding, extrahepatic biliary injury, and switching to conventional cholecystectomy.

Keywords: Cholecystectomy, Cystic artery, Variation

INTRODUCTION

Success and safety in laparoscopic cholecystectomy are related to the importance given to the knowledge about general embryological anomalies of the biliary tract. Blood flow, ductal variations, and gallbladder anatomy of this region are the major source of difficulty for surgeons. The understanding of cystic artery anatomy and variations may reduce complications such as uncontrolled intraoperative bleeding and extrahepatic biliary injury, thereby reducing the possibility of development to open cholecystectomy.¹

The cystic artery originates by taking 1-3 branches from the hepatic artery and is located within Calot's triangle.² The cystic artery shows a high degree of variation. This condition can be seen not only in its origin or number but also in its branches leading to the gallbladder (Figure 1). Regardless of the number and origin, the importance during gallbladder surgery lies in connecting the cystic artery.³

The aim of this study was to become familiar with vascular variations in laparoscopic cholecystectomy.

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METHODS

The files of patients who applied to our clinic between January 2016 and January 2020 for symptomatic gallstones and other benign gallbladder diseases and underwent laparoscopic cholecystectomy operation were retrospectively analyzed.

Inclusion criteria

Gallstones with benign gallbladder diseases, gallbladder polyps (size >1 cm or multiple polyps), previously known gallbladder inflammation, patients without bleeding clotting disorder, being over the age of 18, and patients who can be given general anesthesia induction.

Exclusion criteria

Patients who cannot be given general anesthesia induction, patients with bleeding-clotting disorders, patients with a known malignancy or who have undergone malignancy surgery and who have been followed up in oncology, patients who have undergone hepatobiliary surgery before and under 18 years of age.

Hospitalization indications of all patients included in the study, hepatobiliary ultrasound, additional diseases of patients, other operations performed concurrently with laparoscopic cholecystectomy, complications, reasons for switching from laparoscopy to conventional cholecystectomy and hospitalization times were recorded.

Written consents were obtained from all patients who participated in the study in terms of operation.

Ethical approval was obtained for the study from Clinical Research Ethics Committee of Ministry of Health, Istanbul Medeniyet University Goztepe Training and Research Hospital.

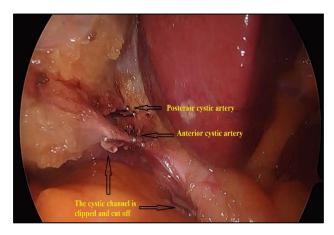


Figure 1: The double cystic artery that occurs after the cystic canal is clipped and cut during laparoscopic cholecystectomy.



Figure 2: In the ERCP procedure, cholangiogram shows a bile fistula from the common bile duct.



Figure 3: Stent placement in the common bile duct with the help of ERCP to the patient who developed a bile fistula.

Distribution of normality of quantitative data was tested using the Shapiro-Wilk test and graphical analyses. Student's t-test was used for inter-group comparisons of normally distributed quantitative data. Categorical data were compared with Pearson chi-square test and Fisher-Freeman-Halton exact test. A p level of <0.05 was considered statistically significant. Statistical analyses were done using number cruncher statistical system (NCSS) 2007 (Kaysville, Utah, USA) program.



Figure 4: Removal of the gallbladder with a double cystic artery from an epigastric hernia defect.

RESULTS

360 laparoscopic cholecystectomy files performed in the last four years were examined. 76 male and 284 female patients were included in the study. The average age was 51.2 (25-81). When the files of the patients were examined, double cystic arteries were detected in the operation of two males (2.63%) and nine female patients (3.16%). The average age of these patients was 54.6±4.1.

It was discovered from ultrasound reports that the indication for operation in one of the 11 patients with double cystic arteries was gall bladder polyp while it was

multiple stones in the gallbladder for the rest of the patients.

When the additional diseases of the patients were examined, oral anti-diabetic-regulated diabetes mellitus was detected in one female patient, and hypertension was detected in one male patient. An epigastric hernia was detected in a patient other than gallstones and an epigastric hernia correction was performed simultaneously laparoscopically.

Two of the 11 patients (18.1%) with double cystic arteries were switched from laparoscopic to conventional cholecystectomy due to bleeding during surgery. In the operation, the bleeding of the cystic artery located in the posterior of the cystic arteries was detected, it was revealed laparoscopically as the hepatic artery could not be distinguished and cholecystectomy was completed after the cystic artery was found to be double and the secretion of the hepatic artery was detected.

Bile duct injury was detected postoperatively in a male patient with a double cystic artery. Upon the detection of 300 ml bile fistula from the postoperative drain of the patient, the injury was detected with the help of MR-cholangiography, and a stent was placed in the common bile duct with the help of endoscopic retrograde cholangiopancreatography (ERCP) (Figure 2 and 3).

The average duration of hospital stay of patients with a double cystic artery is 5.2 (3-11) days, and (2.7 days) for patients without a double cystic artery. Demographic data, clinical features of study participants and the result of the study is given in Table 1. No mortality was detected in the operations of patients with double cystic arteries.

Table 1: Descriptive characteristics by groups.

		Group			
Variables		Single cystic artery (n=349)	Double cystic arteries (n=11)	Total (360)	P value
Age (in years)	Minmax. (median)	25-81 (50.1)	30-71 (54.6)	25-81(51.2)	t:0.665
	Mean±SD (mean)	46.1±14.89	50.8±12.83	48.2±14.50	a0.506
Gender	Male	74 (21.2)	2 (18.2)	76 (21.1)	χ^2 :0.671
	Female	275 (78.8)	9 (81.8)	284 (78.9)	b0.387
Indication	Multiple stones	349 (100)	10 (90.9)	359 (99.7)	$\chi^2:3.184$
	Gallbladder polyp	0 (0)	1 (9.09)	1 (0.3)	^b 0.051*
Switched from laparoscopic to conventional cholecystectomy	No	349 (100)	9 (81.9)	358 (99.4)	χ ² :3.123
	Yes	0 (0)	2 (18.1)	2 (0.6)	b0.038*
Bile duct injury	No	349 (100)	10 (90.9)	359 (99.7)	χ ² :3.184
	Yes	0 (0)	1 (9.09)	1 (0.3)	b0.051*
Hospital stay	Days	2.7 (1-4)	5.2 (3-11)	92 (47.7)	t:0.541
					a0.476*

^aStudent-t test; ^bPearson Chi-Square test; *p<0,05

DISCUSSION

The cystic artery often emerges from the right branch of the proper hepatic artery as a single vessel. In 75-80% of reported cases, the hepatobiliary triangle passes through Calot's triangle. When approaching the gallbladder, the cystic artery is divided into superficial and deep branches. These branches form anastomoses in the gallbladder parenchyma. Variations can be seen frequently during the origin and course of the cystic artery. During laparoscopic cholecystectomy, it was observed that mortality was 0.02% in 1.9% cases who suffered vascular damage. The knowledge of other possible variations in this region is essential for safe cholecystectomy.4,5 In our study, it occurred in two patients who suffered intraoperative bleeding. However, it may have occurred in these patients due to the thought that the hepatic artery was injured.

When the embryology of the cystic artery was examined, the developmental changes occurring in the primitive ventral splanchnic arteries affect the origin and branching of the cystic artery. In the 4th week of gestation, the liver, gallbladder, and bile ducts develop as a hepatic diverticulum from the caudal part of the stomodeum. Hepatic diverticulum grows rapidly and is divided into two parts between the ventral mesogastrium layers. The larger cranial part in hepatic diverticulum is the primordium of the liver. It extends between the hepatocyte cords with the proliferation of endodermal cells and creates intrahepatic bile ducts. The small caudal part of the hepatic diverticulum forms the gall bladder and the handle of the diverticulum forms the cystic duct.⁶

Apart from the double cystic artery, it is essential to connect the cystic artery in laparoscopic cholecystectomy, and some anatomical landmarks should be considered for safe surgery. In conventional and laparoscopic cholecystectomy, it is necessary to know the triangle of Calot's well. The Calot's triangle is an important reference region for cholecystectomy. Rocko described the Calot's triangle formed by the cystic canal, common hepatic canal and lower edge of the liver in 1981. Rocko drew attention to possible variations in this triangle. Hugh renamed the Calot's triangle as a hepatobiliary triangle and named the small cystic artery branches feeding the gallbladder as the arteries of Anatomical landmarks in laparoscopic cholecystectomy have been reported mainly as Rouviere's sulcus, cystic lymph nodes, and arteries. Rouviere's sulcus was reported as a correct landmark for the common hepatic canal plane since the dissection of Calot's triangle was safe at the transverse level. When the facial strip in Calot's triangle is flattened, it can be defined as a pulsating structure with the presence of a cystic artery lymph node. In addition, defining the cystic lymph node can help identify the cystic duct and cystic artery structures.8 In our study, one of the patients with a double cystic artery was found to have a bile fistula, and when the patient's file was examined, it was learned that the patient was operated on the thought of acute cholecystitis.

In our study, the incidence of a double cystic artery was found to be 3.05 on average, while the incidence of double cystic artery ranged from 2 to 25%. However, different values were found in different populations. This condition is associated with the congenital absence of the deep branch of the cystic artery. In the study of Dandekar et al in 82 cadavers, a single cystic artery was in 72% and a double cystic artery was in 28%. Considering the origin of the cystic artery with reference to the Calot's triangle, it was observed that 62.2% were inside the triangle and 37.8% were outside. It was detected that cystic arteries passed through Calot's triangle except for 3.6% of them. It was found that the cystic artery passes in 26.8% of the cases in front of the common hepatic canal while 6.1% passes behind it.⁹ In our study, it was observed that all the double cystic arteries pass through Calot's triangle, but there was no research about the origin of the double cystic artery.

Many of the studies on the incidence of double cystic artery have been done on cadavers. In the study performed by Ding et al in the Chinese people, in 3 of 600 patients (0.5%) double cystic artery approached the gall bladder from the outside of the hepatobiliary triangle. 10 Likewise, in the study of Suzuki et al it was in 13 of 244 patients (5.3%). In the study conducted by Zubair et al on Pakistani population, it was in 26 of 220 patients (11.8%), Talpur et al in his study, the course of the double cystic artery was outside of the hepatobiliary triangle in 3 of 300 patients (1%). 12,13 It is also seen from these studies that the incidence of a double cystic artery in the people of Pakistan differs from a region to another. This shows to us that there may be differences in the results of the studies carried out as they were retrospective.

In some studies, it was found that the double cystic artery originated from the right hepatic artery. For example, Saidi et al, in 8 (7.8%) out of 102 Nairobian patients, 10% in the study of Futara Ethiopian people, Balija et al and Mlakar et al showed that a double cystic artery originated from the right hepatic artery at the rates of 13.6% and 5.5%. ¹⁴⁻¹⁷

The largest study of the origin of the double cystic artery was reported by Sarkar et al compiled accordingly, the cystic artery originated from several areas: right hepatic artery (63.9%), common hepatic truncus (26.9%), left hepatic artery (5.5%), gastroduodenal artery (2.6%), superior pancreaticoduodenal artery (0.3%), right gastric artery (0.1%), celiac body (0.3%) and superior mesenteric artery (0.8%). It can be seen from this study that the double cystic artery originates most often from the right hepatic artery.

All the variations mentioned above generally occur separately. The coexistence of variations in hepatic

arteries with cases of variation associated with double cystic artery is very rare. In this regard, Bincy et al reported double cases of a cystic artery arising from the proper hepatic artery, in this case, the proper hepatic artery originated from the accessorial left hepatic artery. 19 Loukas et al reported a double cystic artery arising from the right hepatic artery and posterior superior pancreaticoduodenal artery. 20 In this study, the accessory left hepatic artery originated from the left gastric artery. Polguj et al reported that biliary tract damage is a major complication in laparoscopic cholecystectomy, and they talked about the importance of seeing a cystic duct and cystic artery in the same plan.²¹ In our study, the coexistence of epigastric hernia was detected in only one patient, but no research was conducted for vascular variations for other patients.

In the operation of the patient with an epigastric hernia and multiple stones in the gallbladder, laparoscopic cholecystectomy and laparoscopic hernia correction were applied simultaneously (Figure 4). Facinelli et al reported that patients with epigastric hernia had less collagen in the abdominal wall than in the normal population. In particular, the amount of type 1 collagen was found to be 20% less than the normal population.²²

Some risk factors for epigastric hernia have been identified. These are observed especially as a result of uncoordinated, strong diaphragm contractions, increased intra-abdominal pressure, and a protrusion defect in linea alba and pre-peritoneal fatty defect. This is especially the case in patients with lung disease and athletes and soldiers who lift high force. In our case, because the patient was a farmer, it enters the population that removes high force.²³

Since our study was retrospective, it gave us information about the incidence of a double cystic artery in only 4 years, thus proving that patients have a higher risk of complications. However, we think that we can achieve different results with prospective broad participation multicenter studies. However, we believe that it is valuable as it is the first study in Turkey about the incidence of the double cystic artery.

CONCLUSION

As a result, cystic artery variations occur at different rates. Clarifying the anatomy of Calot's triangle anatomy and ensuring the operation with a safe surgery by paying attention to the anatomical landmarks, reduces complications such as hemorrhage and bile leakage, and prevents the development of conventional cholecystectomy. Recognition of cystic artery anatomy and variations, considering that we may encounter other variations besides cystic artery variations; reduces the risk of uncontrolled intraoperative bleeding and extrahepatic biliary injury. Surgeons who prefer minimally invasive surgical procedures should follow

new anatomical developments and be aware of possible arterial and biliary tract variations.

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REFERENCES

- Sidana K, Jadav HR, Patel BG. The prevalence of double cystic artery: a cadaveric study. GCSMC J Med Sci. 2016;5(2):116-9.
- 2. Li LJ, Zheng XM, Jiang DZ, Zhang W, Shen HL, Shan CX, et al. Progress in laparoscopic anatomy research: A review of the Chinese literature. World J Gastroenterol. 2010;16(19):2341-7.
- 3. Veena P, Subhash LP, Anupama D, Nagaraj DN. Dual cystic artery- a case report. Anatomica Karnataka. 2011;5(2):52-4.
- 4. Eyni H, Pasbakhsh P, Azimi A, Fard SB. Case report: variation of the gallbladder vasculature including double cystic arteries. Anatom Sci. 2015;12(1):51-5.
- 5. Chen TH, Shyu JF, Chen CH, Ma KH, Wu CW, Lui WY, et al. Variations of the cystic artery in Chinese adults. Surg Laparosc Endosc Percutan Tech. 2000;10(3):154-7.
- 6. Hlaing KP, Thwin S, Shwe N. Unique origin of the cystic artery. Singapore Med J. 2011;52(12):263.
- 7. Hugh TB, Kelly MD, Li B. Laparoscopic anatomy of the cystic artery. Am J Surg. 1992;163:593-5.
- 8. Singh K, Ohri A. Anatomic landmarks: their usefulness in safe laparoscopic cholecystectomy. Surg Endosc. 2006;20:1754-8.
- 9. Dandekar U, Dandekar K, Chavan S. Right hepatic artery: a cadaver investigation and its clinical significance. Anat Res Int. 2015; 2015:412595.
- Ding YM, Wang B, Wang WX, Wang P, Yan JS. New classification of the anatomic variations of the cystic artery during laparoscopic cholecystectomy. World J Gastroenterol. 2007;13(42):5629-34.
- Suzuki M, Akaishi S, Rikiyama T, Naitoh T, Rahman MM, Matsuno S. Laparoscopic cholecystectomy, Calot's triangle, and variations in cystic arterial supply. Surg Endosc. 2000;14(2):141-4.
- 12. Zubair M, Habib L, Mirza RM, Cnanna MA, Yousuf M, Quraishy MS. anatomical variations of cystic artery: telescopic facts. Med J Malaysia. 2012;67(5):494-6.
- Talpur KA, Laghari AA, Yousfani SA, Malik AM, Memon AI, Khan SA. Anatomical variations and congenital anomalies of extra hepatic biliary system encountered during laparoscopic cholecystectomy. J Pak Med Assoc. 2010;60(2):89-93.

- 14. Saidi H, Karanja TM, Ogengo JA. Variant anatomy of the cystic artery in adult Kenyans. Clin Anat. 2007;20(8):943-5.
- 15. Futara G, Ali A, Kinfu Y. Variations of the hepatic and cystic arteries among Ethiopians. Ethiopian Med J. 2001;39(2):133-42.
- 16. Balija M, Huis M, Nikolic V, Stulhofer M. Laparoscopic visualization of the cystic artery anatomy. World J Surg. 1999;23(7):703-7.
- 17. Mlakar B, Gadzijev EM, Ravnik D, Hribernik M. Anatomical variations of the cystic artery. Eur J Morphol. 2003;41(1):31-4.
- 18. Sarkar AK, Roy TS. Anatomy of the cystic artery arising from the gastroduodenal artery and its choledochal branch- a case report. J Anat. 2000;197(3):503-6.
- 19. Bincy MG, Somayaji SN. Multiple variations of the subhepatic hepatobiliary vasculature porta. Int J Anatomy. 2010;3:39-40.
- Loukas M, Fergurson A, Louis RG Jr, Colborn GL. Multiple variations of the hepatobiliary vasculature

- including double cystic arteries, accessory left hepatic artery and hepatosplenic trunk: a case report. Surgical Radiologic Anatomy. 2006;28(5):525-8.
- Polguj M, Podgórski M, Hogendorf P, Topol M. Variations of the hepatobiliary vasculature including coexistence of accessory right hepatic artery with unusually arising double cystic arteries: case report and literature review. Anat Sci Int. 2014;89(3):195-8.
- 22. Fachinelli A, Trindade MR, Fachinelli FA. Elastic fibers in the anterior abdominal wall. Hernia. 2011;15(4):409-15.
- 23. Sorensen LT. Effect of lifestyle, gender and age on collagen formation and degradation. Hernia. 2006;10(6):456-61.

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