Study of Abnormal Anatomical Variations in Extrahepatic Biliary Apparatus and Its Related Vessels in Cadavers

Mahim Koshariya, Sovat Lal Ahirwar, Arshad Khan, Mool Chand Songra

Corresponding author:

Dr. Mahim Koshariya
Department of Surgery, Gandhi
Medical College & Associated
Hamidia Hospital, Bhopal, India
E-mail: mahimk2000@yahoo.co.uk

Department of Surgery, Gandhi Medical College & Associated Hamidia Hospital, Bhopal, India

ABSTRACT

Background: In the current era, the laparoscopic procedure such as laparoscopic cholecystectomy, laparoscopic hepatobiliary surgery and other open procedures such as open cholecystectomy, biliary stricture surgery, are performed regularly throughout the world and extrahepatic biliary tract is one of the most common sites of the surgical procedures. The incidence of biliary tract injury by laparoscopic cholecystectomy has been found to be higher than open cholecystectomy. Apart from various other causes of biliary injuries aberrant anatomical course of extrahepatic biliary system is a well established fact of iatrogenic ductal injury. Thus, an adequate recognition and awareness of anatomical abnormalities of extra hepatic biliary tree with its vessel, can decrease the morbidity and mortality related to the surgery.

Methods: Study was done in Department of Surgery, Gandhi Medical College and Hamidia Hospital Bhopal, India on 100 cases, during period of Aug 2014 to Nov 2015, and dissection was carried out in department of Forensic Medicine and Toxicology after taking permission from ethical committee.

Results: In 100 cases of study 72 were male and 28 were female in which 16% male and 10.7% female showed variations in their anatomy. The most common variation which we observed in our study was short cystic duct in 8 cases, and second most common variations was cystic artery origin, from left hepatic artery in 3 cases and from proper hepatic artery in 1 case, other variations were floating gall bladder in 1 case, intrahepatic union of left hepatic duct and right hepatic duct in 3 cases, low insertion of cystic duct in 3 cases, high insertion of cystic duct to common hepatic duct in 1 case, and in one case cystic artery passing anterior to common hepatic duct.

Conclusion: There was a significant variations seen in extrahepatic biliary apparatus and its related arterial supply in our study, and these variations observed could definitely be useful to hepatobiliary, laparoscopic surgeons and radiologist. And will further contribute to literature available on variations of extrahepatic biliary system.

Abbreviations: GB - Gallbladder, CHD - Common Hepatic Duct, CBD - Common Bile Duct, CD - Cystic Duct, RHD - Right Hepatic Duct, LHD - Left Hepatic Duct

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INTRODUCTION

In the current era, laparoscopic surgical procedures have become common

therapeutic methods and are performed regularly throughout the world. The laparoscopic procedures such as laparoscopic cholecystectomy, laparoscopic biliary surgery such as CBD exploration for stone diseases, laparoscopic liver resection and other open procedures such as open cholecystectomy, biliary stricture surgery, liver transplantation, whipple procedure, biliary drainage procedure demand high technical skills as well as thorough knowledge of biliary anatomy and its variations. Therefore, to minimize complications, a sound knowledge of the normal anatomy of extrahepatic biliary tract is thus essential in the prevention of operative injury to it. Equally important, however, is an understanding of congenital variation of biliary and vascular anatomy, as the literature abounds with reports of specific anatomical variations, and their operative implications.

Gallbladder surgery is one of the most commonly performed biliary surgery and laparoscopic cholecystectomy has become the new gold standard for management of gall stone disease (1). It has been rapidly adopted by the surgeons over all the world. The incidence of biliary tract injury by laparoscopic cholecystectomy has been found to be higher than open cholecystectomy (2,3). Apart from various other causes of biliary injuries aberrant anatomical course of extrahepatic biliary system is a well established fact of iatrogenic ductal injury. Thus, an adequate recognition and awareness of anatomical abnormalities of extrahepatic biliary tree with its vessel, can decrease the morbidity and mortality related to the surgery. The anatomy facing a surgeon during hepatobiliary surgery involves complex relationships between the gallbladder hepatic artery and extrahepatic biliary tree.

Extrahepatic biliary apparatus comprises of right hepatic duct and left hepatic duct, common hepatic duct, gallbladder, cystic duct and common bile duct.

The commencement is at the formation of common hepatic duct by the union of right and left hepatic ducts. It terminates by uniting with the pancreatic duct at ampulla of Vater which opens in second part of duodenum. Review of literature in this regard, showed several studies where in variation of extrahepatic biliary apparatus were mentioned.

Living related donor liver transplantation has emerged as an alternative to cadaveric liver transplantation because of shortage of available cadaveric liver and drastic increase in demand for transplantation. Pre-operative assessment of potential liver donor requires hepatic vascular and biliary anatomy delineation. In adult right hepatic lobe transplantation

is usually the procedure of choice to provide adequate liver volume to recipient (4).

Congenital anomalies of extrahepatic biliary tree have long been recognised but are rare and may be of clinical importance because they may provide surgeons with unusual surprise during surgeries. These anomalies include aberrant or accessory bile duct, aberrant cystic duct, bile duct, anomalous bile duct along with vascular anomalies. Recognition of these entities on anomalies and normal variant may avoid diagnostic error, and in surgical planning and prevent inadvertent ductal injuries (5).

With advances in drugs and surgical technology very complex surgical procedures are now being done with very less morbidity and mortality. The success and safety of laparoscopic cholecystectomy, orthotopic liver transplantation, and surgery on hepatobiliary system depend on a high regard for an accurate knowledge of the common embryologic anomalies of the biliary tree. In view of this we took this research work to study the abnormal anatomical variations in extrahepatic biliary apparatus and its related vessels to further contribute to the existence medical literature.

MATERIAL AND METHODS

This was an observational study done in the department of surgery on 100 cadavers and dissection was carried out in the department of forensic medicine and toxicology after taking permission from ethical committee.

This study followed cadaveric dissection by opening the abdomen by midline and exploring, dissecting the hepatobiliary area. First of all gallbladder was identified and details were noted, then cystic duct was dissected and its accompanying cystic artery was identified. Cystic duct was followed till its junction with common hepatic duct and then common bile duct was dissected and delineated. Length and angulations of cystic duct was noted. Length of CBD and its variation if any was noted. Then common hepatic duct was traced caudally till its branching and length was noted. Cystic artery was carefully followed till its origin and details were noted. At the same time course of cystic artery in relation to hepatic ducts was noted and search for any accessory cystic artery was made, dissection was carried out till delineation of proper hepatic artery, anatomical course and its branching in relation to portahepatis after noting above details, any gross anatomical variations if present were noted and photographs were taken. (fig. 1-10)

Figure 1 - Showing normal anatomy of extrahepatic biliary apparatus

Figure 2 - Showing high union of cystic duct with common hepatic duct

Figure 3 - Showing relation of extrahepatic biliary tract to its related vessels

Figure 4 - Showing low insertion of cystic duct with common hepatic duct

Figure 5 - Measuring length of cystic duct, common hepatic duct and common bile duct

Figure 6 - Showing cystic artery running posterior to common hepatic duct

Figure 7 - Showing extrahepatic union of left hepatic duct with right hepatic duct

Figure 8 - Showing floating gall bladder

Inclusion and Exclusion criteria

Inclusion criteria

- All cadaver of age group 13 years onwards.

Exclusion criteria

- Decomposed bodies;
- Those who have undergone Hepatobiliary surgery;
- Hepatobiliary Malignancy.

RESULTS

In 100 cases of study 72 were male 28 were female in which 16% male 10.7% female showed variations in their anatomy. The following observations and results were noted.

1. Formation of common hepatic duct by union of right hepatic duct and left hepatic duct was extrahepatic in 97 cases and intrahepatic in 3 cases (table 1, graphic 1).

Figure 9 - Showing short cystic duct

Figure10 - Showing intrahepatic union of left hepatic duct and right hepatic duct

ABNORMAL ANATOMICAL VARIATION IN EXTRAHEPATIC BILIARY APPARATUS AND ITS RELATED VESSEL

Site of Anomaly	Type of Anomaly	No. of patient	Percentage
Gallbladder (n=1),1%	1. Floating gall bladder	1	1%
Cystic duct (n=11),15%	1. Short cystic duct (1.6 cm)	8	8%
	2. Long cystic duct (>4.5 cm)	3	3%
	3. Running parallel to common hepatic duct and low insertion	3	3%
	4. High insertion of cystic duct	1	1%
	5. Accessory cystic/hepatic duct	0	0%
Union of right and left hepatic duct (n=3),3%	1. Intra-hepatic	3	3%
Cystic Artery (n=5),5%	1. Originating from Left hepatic artery	3	3%
	2. Originating from proper hepatic artery	1	1%
	3. Cystic artery passing anterior to common hepatic duct	1	1%
	5. Accessory cystic Artery	0	0%

Variations seen in 15 cases out of 100 cases.

2. Union of cystic duct with common hepatic duct was of normal type i.e. angular type in 97 cases, and in 3 cases union was parallel type (table 2, graphic 2).
3. There was low insertion of cystic duct with common hepatic duct in 3 cases and in 1 case there was high type of insertion i.e. near bifurcation of right and left hepatic duct (table 3, graphic 3).
4. Short cystic duct was found in 8 cases (8%) i.e. < 1.6 cm and long cystic duct in 3% of cases.
5. Cystic artery originating from right hepatic artery

in 96 cases and in 3 cases, cystic artery originating from left hepatic artery, and in 1 case cystic artery originating from hepatic proper artery was found (table 4, graphic 4).

6. In 99 cases cystic artery was posterior to common hepatic duct, and in 1 case cystic artery was anterior to common hepatic duct (table 5, graphic 5).
7. Average length of cystic duct was 3.1 cm, and common hepatic duct 2.67 cm and length of common bile duct was 7.18 cm (table 7,8,9, graphic 7, 8,9).

Table 1 - Union of right hepatic duct with left hepatic duct

Union of right hepatic duct with left hepatic duct	Number of cadavers (out of 100)	Percentage
Extrahepatic	97	97%
Intrahepatic	3	3 %

In 100 cases of study there is 97% extrahepatic union of right and left hepatic artery and 3% is intrahepatic union.

Graphic 1**Table 2 - Union of cystic duct with common hepatic duct**

Union of cystic duct with common hepatic duct	Number of cadavers (out of 100)	Percentage
Angular type	97	97 %
Parallel type	3	3 %
Spiral type	0	0 %

Union of cystic duct with common hepatic duct is angular type in 97% cases and in 3% cases is parallel type

Graphic 2**Table 3 - Insertion of cystic duct into common hepatic duct**

Insertion of cystic duct into common hepatic duct	Number of cadavers (out of 100)	Percentage
Normal insertion	96	96 %
High insertion	1	1 %
Low insertion	3	3 %

Insertion of cystic duct into common hepatic duct is normal in 96% cases, high insertion in 1 case and low insertion in 3% cases

Graphic 3**Table 4 - Origin of cystic artery**

Origin of Cystic artery	Number of cadavers (out of 100)	Percentage
Right hepatic artery	96	96 %
Left hepatic artery	3	3%
Proper hepatic artery	1	1%

In 96% cases the origin of cystic artery is from Right hepatic artery, 3% cases from left hepatic artery and in 1% cases from proper hepatic artery.

Graphic 4

Table 5 - Relation of cystic artery with common hepatic duct

Relation of cystic artery with CHD	Number of cadavers (out of 100)	Percentage
Anterior	1	1%
Posterior	99	99%

In 99% of cases cystic artery passes posterior to common hepatic duct and in 1 cases anterior to common hepatic duct

Graphic 5**Table 6 - Multiple anomalies**

Number of anomalies	Number of cadavers (out of 100)	Percentage
3	3	3%
2	3	3%
1	9	9%

Out of 100 cadavers 3% having 3 anomalies, 3% having 2 anomalies and 9% having single anomalies

Graphic 6**Table 7 - Length of common bile duct**

Length of common bile duct (in cm)	Number of cadavers (out of 100)	Percentage
4.5-5.5	11	11%
5.6-6.5	15	15%
6.6-7.5	54	54%
>7.6 cm	20	20%

In 54% cadavers length of common bile duct was observed to be in range of 6.6-7.5 cm, 11% were between 4.5-5.5 cm, 15% between 5.5-6.5 and 20% having >7.6 cm

Graphic 7**Table 8 - Length of cystic duct**

Length of Cystic duct (in cm)	Number of cadavers (out of 100)	Percentage
1.0-2 cm	11	11%
2.1-2.5 cm	21	21%
2.6-3 cm	25	25%
3-3.5 cm	31	31%
>3.5 cm	12	12%

In 31% of cadavers length of cystic duct was observed in range of 3-3.5 cm, 25% in between 2.6-3 cm, 21% between 2.1-2.5 cm, 12% > 3.5 cm and 11% in between 1.5-2 cm

Graphic 8

Table 9 - Length of common hepatic duct

Length of Common hepatic duct (in cm)	Number of cadavers (out of 100)	Percentage
1.5-2 cm	12	12%
2.1-2.5 cm	32	32%
2.6-3 cm	49	49%
>3	7	7%

Length of common hepatic duct was observed in 49% cadaver in between 2.6-3 cm and 32% in between 2.1-2.5 cm, in 12% between 1.5-2 cm and 7% is >3 cm.

Graphic 9

8. In 99 cases gallbladder was normal and in 1 case gallbladder was of floating type (not adhered to liver surface).
9. There was incidental finding of gallbladder calculus in 9 cases.

DISCUSSION

It is imperative to have a proper knowledge regarding the anatomy and its associated anatomical variations before any surgery especially in hepatobiliary system which is known for various associated anomalies and its anatomical variations. Despite so many studies done on the normal anatomy and its variations of hepatobiliary system and being aware of variations, human error can commit iatrogenic injuries to the important structures during cholecystectomy and other hepatobiliary surgeries, majority being biliary injuries.

In the past, various extensive studies have been done on abnormal anatomical variations of extrahepatic biliary apparatus that has made evident various abnormal anatomical variations. We did our study on

100 cadavers to look for further anatomical variations and to add more to the existing medical literature. The most common extrahepatic biliary tract anatomical variation which we observed in our study was short cystic duct in 8 cases and the second most common variation was cystic artery origin, from left hepatic artery in 3 cases and from proper hepatic artery in 1 case.

We discuss here in detail the various anatomical variations which we came across in our present study (table 10).

1. The right and left hepatic duct from the corresponding lobes of liver unite to form common hepatic duct either extrahepatically or intrahepatically.

Brewer (1900) from dissection of 50 specimens found 100% extrahepatic union of right and left hepatic duct.

Rugg (1908) studied 43 cadavers, in that he observed extrahepatic union of right and left hepatic duct in 79% and intrahepatic union of right and left hepatic duct in 21% (6).

Thompson dissected 50 specimen in 1933 and noted 90% extrahepatic union and 10% intrahepatic union of right and left hepatic ducts (7).

In our study on 100 cadavers' extrahepatic union of right and left hepatic union was noted in 97% and intra-hepatic union in 3%.

2. The junction of cystic duct with common hepatic duct which is of surgical importance is highly variable.

Three types of union of cystic duct with common hepatic duct namely:

1. Angular type;
2. Parallel type;
3. Spiral type.

43 cadavers dissected by Rugg (1908) and he reported angular type 35% parallel type 20% and spiral type 45% (6).

Eisendrath's (1918) study on 100 specimens showed angular type 75% parallel type-17% and spiral type-8%.

Thompson (1933) dissected 50 cases and observed angular type-90% parallel type 6% and spiral type 4% (7).

In present study, angular types was seen in 97%, parallel type in 3% and spiral type of union was not found.

In parallel type of union both the cystic duct and common hepatic duct were closely bound together hence their separation become difficult. In parallel type

Table 10 - Comparison of present study with past studies

S. No.	Author	year	No. of cases	Union of LHD with RHD			Union of CD with CHD			Level of termination			Presence of accessory CD/ HD	Length of individual ducts(in cm)				Origin of cystic artery (in percentage)				Acc. CA(%)	Relation of CA with CHD	
				EH	IH		Angular	Parallel	Spiral	High	Normal	Low		CD	CHD	CBD	RHA	LHA	PHA	GD	others		Ant.	Post
1.	Brewer	1900	50	100%	0%																			
2.	Rugg	1908	43	79%	21%		35%	20%	45%															
3.	Thompson	1933	50	90%	10%		90%	6%	4%															
4.	Eisendrath	1918	100				75%	17%	8%													27%		73%
5.	Hossein Mahour	1961	100							15%	80%	18%												
6.	Edward Desler	1947	580										1.6%				71.7	6.2	0	2.6	19.3			
7.	F.R.Flint	1922-23	200														98	1.5		0.5		15	16%	84%
8.	Henry Gray	2008												3-4	3	7.5								
9.	Henry Hollinshead	1954												2.5-7.5	2.5-7.5	5-15								
10	Mahim Koshariya [Present study]	2014-15	100	97%	3%		97%	3%	0%	1%	96%	3%	0%	2-4	2-3	6-8	96	3	1	0	0	0	1%	99%

of union, the two ducts may closely adherent to each other. So it is difficult to put a clamp without injuring common hepatic duct.

3. The level of termination of cystic duct with hepatic duct can be: 1. High level; 2. Low level; 3. Normal level.

In high level of union cystic duct unite with common hepatic duct close to the bifurcation of right and left hepatic ducts, in this level the common hepatic duct length is very small than its average and common bile duct length is more.

In low level of termination, the cystic duct unites with common hepatic duct further away from the bifurcation to make common hepatic duct longer than common bile duct.

In normal level of union common bile duct is longer than common hepatic duct.

Hossein Mahour in (1961), from a study on 100 autopsies described about the height of termination of cystic duct. In 80% normal level of union, in 18% of cases low level of union and in 1.5% of cases high level of union was noted (8).

In present study, normal level of union of cystic duct with common hepatic duct was seen in 96% i.e. Normal and low insertion was seen in 3%, and high type insertion was seen in 1 case i.e. 1%.

The level of union high or low insertion of cystic duct carries significance because of potential for injury in biliary surgery (9). Thus it is of utmost importance to keep in mind the various aberration and course of cystic duct before ligation or clipping it in order to avoid any inadvertent injury to the biliary tract.

4. Presence of accessory cystic or hepatic duct

Schachner (1916) studied 76 specimen and in that he noted double cystic duct in 2 cases, absence of common bile duct in 1 case (10).

Gray's (1936) stated that accessory hepatic duct is more common with right lobe of liver (11).

Edward H. Daseler (1947) worked on 500 cases and visualized accessory right hepatic duct in 8 cases (1.6%) (12).

In present study no accessory hepatic or cystic duct was present.

5. Length of individual duct

Hollinshead (1954), stated the length of cystic duct as 2.5-7.5 cms, length of common hepatic duct as 2.5-7.5 cms, length of common bile duct as 5-15 cms (13).

The Gray's Anatomy (2008), mentioned the average length of cystic duct is 3-4 cms, length of common hepatic duct is 3 cms and length of common bile duct is 7.5 cms (11).

In present study the average length of cystic duct was 2-4 cms, average length of common hepatic duct was 2-3 cms; average length of common bile duct was 6-8 cms.

There was short cystic duct in 8 out of 100 cases. Short cystic duct is an important factor for misidentification and reason for biliary injury. Careful dissection and delineation of can avoid injury when short cystic duct is encountered.

6. Origin of cystic artery

F.R. Flint (1922-3) worked on 200 subject and found the origin of cystic artery from right hepatic artery in 98% from left hepatic artery in 1.5% cases and from gastroduodenal in 0.5%.

Hollinshead (1954) also described that cystic artery arises from right hepatic artery. He also added it may also arise from left hepatic artery and common hepatic artery (13).

In Gray's Anatomy (2008) it's mentioned that cystic artery arising from right hepatic artery. He also stated that cystic artery may arise sometime from common hepatic artery left hepatic artery and gastroduodenal artery (11).

In present study the cystic artery was arising from right hepatic artery in 96% cases and from left hepatic artery in 3% cases and from hepatic proper artery in 1% cases.

7. Accessory cystic artery

Flint (1922-23) studied 200 specimens and observed accessory cystic artery in 31 cases in that in 51.6% (16) of cases it arise from right hepatic artery, in 9.6% (3) cases from common hepatic artery, 35.4% (11) from gastroduodenal artery and 3.1% (1) from gastroduodenal artery (14).

Grays anatomy (2008) also mentioned that accessory cystic artery arising from common hepatic artery.

In present study no accessory cystic artery found.

8. Cystic artery in relation to common hepatic duct

Eisendrath (1918) studied about 100 specimens. He described in both the studies artery passing dorsal to common hepatic duct is found to be high in number. Ventral to CHD in 27% and dorsal to CHD in 73%.

Flint (1922-23) dissected 200 specimens and stated

cystic artery passing in front of common hepatic duct in 16% and passing behind common hepatic duct in 84% cases (14).

Gray's Anatomy (2008) also mentioned that cystic artery can either pass anterior or posterior to common hepatic duct (11).

In present study the cystic artery passing posterior to common hepatic duct was seen in 99 % and anterior in 1% cases.

The degree of variation in the vascular pattern encountered in this area is of vital importance. The increasing number of operations performed for obstructive jaundice and biliary fistula due to man made injuries of the common bile duct and the hepatic duct calls for the more detail knowledge of the blood vessel in gastrohepatic region. Hence identification of major structure in this area before clipping or ligation is important to prevent any vascular injury.

The course of cystic artery is so variable and the occurrence of the double cystic artery, aberrant cystic artery is so common, hence careful ligation of artery is essential. The more frequent damage is that ligation of cystic duct and cystic artery in a single tie leading to severe haemorrhage and necrosis.

In 1891, Calot described a triangular anatomic region formed by the common hepatic duct medially, the cystic duct laterally, and the cystic artery superiorly (15). Calot's triangle is considered by most to comprise the triangular area with an upper boundary formed by the inferior margin of the right lobe of the liver, rather than the cystic artery (9,16). A thorough appreciation of the anatomy of Calot's triangle is essential during performance of a cholecystectomy because numerous important structures pass through this area. In most instances, the cystic artery arises as a branch of the right hepatic artery within the hepatocystic triangle. A replaced or aberrant right hepatic artery arising from the superior mesenteric artery usually courses through the medial aspect of the triangle, posterior to the cystic duct. Aberrant or accessory hepatic ducts also may pass through Calot's triangle before joining the cystic duct or common hepatic duct (17).

There was incidental finding of gallstone in 9 cases in our study. In recent years the laparoscopic cholecystectomy is most commonly performed procedure. Although the advantage of laparoscopic cholecystectomy are acknowledged, its limitation and unique complication should be kept in mind, there is significantly higher incidence of bile duct injuries in laparoscopic cholecystectomy (0.2-0.8%) compared to open cholecystectomy (0.1-0.25%) (18,19).

CONCLUSION

Thus there was a significant variations seen in extra hepatic biliary tract, and its related arterial supply in our study, and these variations observed could definitely be useful to Hepatobiliary, laparoscopic, general surgeons, and radiologists.

The various variations and anomalous course seen in the present study of extrahepatic biliary apparatus (system) further reinforce our knowledge as well as the literature available on the topic suggesting that hepatobiliary system has got the most variations from the normal anatomical course in the body. The most common anatomical variation seen in our study was short cystic duct followed by the origin of cystic artery.

It further authenticates our knowledge regarding the abnormal anatomical variations seen in extra-hepatic biliary system and its related vascular structures that necessitates proper delineation of anatomy in current era of laparoscopic surgery, complex and technically demanding hepatobiliary procedures to avoid inadvertent injuries to major structures.

It can further prevent morbidity and mortality which occurs due to intraoperative injuries arising from ignorance or improper knowledge of anatomy and its related anatomical variations.

REFERENCES

1. Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW. Laparoscopic cholecystectomy the new 'Gold Standard'? Arch Surg. 1992;127(8): 917-923.
2. Nuzzo G, Giulianti F, Giovannini I, Ardito F, D'Acapito F, Vellone M, et al. Bile duct injury during laparoscopic cholecystectomy: results of an Italian national survey on 56 591 cholecystectomies. Arch Surg. 2005 Oct;140(10):986-92.
3. Richardson MC, Bell G, Fullarton GM. Incidence and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. West of Scotland Laparoscopic Cholecystectomy Audit Group. Br J Surg. 1996 Oct;83(10):1356-60.
4. Umar A, Zhen-hua MA, Cheng-en P, Qing-yong MA. Surgical complication from biliary tract surgery. Journal of US-china Medical Science. 2007;4(2):27.
5. Macdonald DB, Haider MA, Khalili K, Kim TK, O'Malley M, Greig PD, et al. Relationship between vascular and biliary anatomy in living liver donors. AJR Am J Roentgenol. 2005 Jul;185(1):247-52.
6. Rugg E. Beitrage zur Chirurgischen Anatomie der Grossen Gallenwege: Arch f. klin. 1908;37:47-78.
7. Thompson JM. Arteries in the hepatic pedicle, study in statistical human anatomy Univ. Califo pub Anatomy. 1933;158:555.
8. Mahour GH, Wakim KG, Ferris DO. The common bile duct in man: its diameter and circumference. Ann Surg 1967 Mar;165(3):415-19.
9. Skandalakis JE, Gray SW, Rowe Jr JS: Biliary tract. In: Skandalakis JE, Gray SW, ed. Anatomical Complications in General Surgery. New York: McGraw-Hill; 1983. p. 31.
10. Schachner A. Anomalies of the gall-bladder and bile-passages: with the report of a double gall-bladder and a floating gall-bladder. Ann Surg. 1916 Oct;64(4):419-33.
11. Gray H. Grays Anatomy descriptive and applied. 28th edition, Editor T.B. Johnston. Hardcover; 1938.
12. Daseler EH, Anson BJ, Hambley WD, Reimann AF. The cystic artery and constituents of the hepatic pedicle: a study of 500 specimens. Surg Gynecol Obstet. 1947 Jul;85(1):47-63.
13. Hollinshead H. Anatomy for surgeon, Paul B Hoeber (ed), vol. 2. Inc Medical book dept of Harper and Brothers; 1952.
14. Flint ER. Abnormalities in anatomy of bile tract. Abnormalities of the right hepatic, cystic, and gastroduodenal arteries, and of the bile-ducts. BJS. 1923;10(4):509-519.
15. Rock J, Swan KG, Diego J. Calot's triangle revisited. Surg Gynecol Obstet. 1981 Sep;153(3):410-4.
16. Specht MJ: Calot's triangle. JAMA. 1967 June ;200(13):1186.
17. Brunicaudi FC, Anderson DK, Billiar TR, Dunn DI, Hunter JG, Matthews JB, Pollock RE. Schwartz's principle of surgery. 10 edition. 2003.
18. Shamiyeh A, Wayand W. Laparoscopic cholecystectomy: early and late complications and their treatment. Langenbecks Arch Surg. 2004 Jun;389(3):164-71.
19. Richardson MC, Bell G, Fullarton GM. Incidence and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. Br J Surg. 1996 Oct;83(10):1356-60.