Original Article

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Surgical Oriented Anatomical Study of Variations in Extra-Hepatic Biliary Ductal System & Its Related Vessels with its Clinical Significance

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ABSTRACT

Background: Basic prerequisites for being a good surgeon are knowledge, and understanding of anatomyand embryology. Proper understanding of general knowledge of anatomy and embryology are the basic pre-requisites for being a good surgeon.The bile duct injury is a rare but one of the most common complications. Variations are important to the surgeon because failure to recognize them may lead to inadvertent ductal ligation, biliary leaks, Haemobilia, Hemorrhage and Strictures after laparoscopic or open cholecystectomy.

Methods: 200 cadavers subjected for post-mortem examination in Forensic Deptt., M.Y. Hospital, Indore.

Result: Variations in gall bladder is seen in respect to shape is seen in case no 115.Hartman's pouch is seen in 26 cases out of 200.The right and left hepatic ducts united outside the porta hepatis to form the common hepatic duct in 141/200 (70.5%) specimens.The average length of the ducts observed in the study are Cystic duct 2-4 cms, common hepatic duct 2-3 cms and common bile duct 5-8 cms.Three types of union of cystic duct with common hepatic duct.1).Angular type: - observed in 150 specimens (75%), 2)Parallel type: 40 specimens (20%) were observed to be parallel type 3) Spiral type: 5% (10 cases) of the specimens were found to be of spiral type. Level of termination of cystic duct: normal level was observed in 172 (86%) specimens. High level union was noted in 8 specimens (4%).

Conclusion: Many variations have established in this region and understanding of these variations is undoubtedly important for operating surgeons.

Keywords: *Hepatic duct, Common bile duct, cystic duct, Gall bladder*

Introduction

Basic prerequisites for being a good surgeon are proper knowledge, and understanding of anatomy, embryology and histology. Proper understanding of general embryology knowledge of anatomy and histology are the basic pre-requisites for being a good surgeon. Hepatobiliary surgery constitute a major part of day to day practice of general surgeons. Cholecystectomy is the most commonly performed surgical procedure in general surgery. However, the bile duct injury is a rare but one of the most common complications. Variations in the anatomy of gallbladder, bile ducts and the arteries that supply them and liver are important to the surgeon because failure to recognize them may lead to inadvertent ductal ligation, biliary leaks, Haemobilia, Hemorrhage and Strictures after laparoscopic or open cholecystectomy. Living related donor liver transplantation has emerged as an alternative to cadaveric liver transplantation because of the shortage of available cadaveric livers and drastic increase in demand for transplantation. Preoperative assessment of potential liver donors is requiring hepatic vascular and biliary anatomy. These variations although rare in man but can be the basis of serious and fatal complications, therefore, we wish to report the usual and unusual anomalies encountered in our study, knowledge about them would help in avoiding complications due to ignorance. Equipped with factual anatomical knowledge surgeon may proceed with utmost confidence calmness and patience. Efficiency of his hand depends on knowledge that guides it. Therefore, this study was carried out randomly in cadavers, most of them were Medicolegal cases died of various causes like, accidents, burns, homicides, suicides an were brought for Post-Mortem examination to the Deptt. Of Forensic Medicine, M.G.M. Medical College and M.Y. Hospital, Indore.

Aims and Objectives

1. To study the pattern of extra hepatic biliary tract system in cadavers.
2. To state the incidence of various anomalies encountered in the extra hepatic duct system

3. To state the incidence and type of variations in cystic and hepatic blood vessels and their relation with surrounding structures.

Materials And Methods

Materials

1. 200 cadavers subjected for post-mortem examination in Forensic Deptt., M.Y. Hospital, Indore.

Method

1. The cadaver's chest and abdomen was opened by a long standard midline incision extending from chin to suprapubic region.
2. The small intestine and stomach were retracted downward and laterally towards left.
3. At the epiploic foramen the constituents of the pedicle may all be grasped together between thumb and forefinger.
4. At this level they are typically simple, and simply arranged, consisting only the CBD, Hepatic artery, Portal vein.
5. Of these three, CBD normally lies anteriorly and to the right, while the hepatic artery also commonly lies anteriorly, just to the left of CBD, the portal vein lies behind the duct and the artery,
6. Lower down Kocherisation of duodenum was done by blunt dissection, so that 'C' of duodenum was freed along with head of pancreas, both the structures are mobilized anteriorly, and CBD traced along the parenchyma of pancreas, entering into 2nd part of duodenum, pancreatic duct was traced , and dissected in pancreas posteriorly.
7. The **Duodenotomy** was performed along the convex border of 'C' of duodenum, and Ampulla of Vater was traced, its opening upto 4 mm was taken as normal.
8. The Gall Bladder was dissected free from the liver bed by blunt dissection, taking care if any Accessory ducts, or Cholecystohepatic ducts were there, then they were identified accordingly.
9. The gall bladder was opened transversely, carefully to look for any Septum , Diaphragm , Stones, etc.
10. The right and left hepatic ducts, common hepatic duct, cystic duct, common bile duct length were measured by measuring tape.
11. Lastly, quadrate lobe and left lobe of liver was visualized for any accessory ducts.

Result

The findings that are observed by dissecting 200 postmortem specimens are stated below

I. Variations in gall bladder (Figure 4) Variations in gall bladder is seen in respect to shape is seen in case no 115.Hartman's pouch is seen in 26 cases out of 200. In case no 46 and 68 intrahepatic gall bladder is seen. Whereas in case no 56 and 136 floating gall bladder is seen.

II. Formation of common hepatic duct:

1. Extra hepatic union of right and left hepatic ducts: The right and left hepatic ducts united outside the porta hepatis to form the common hepatic duct in 141/200 (70.5%) specimens.

2. **Intrahepatic union of right and left hepatic ducts:** In the remaining 59/200 (29.5%), specimens the right and left ducts united intrahepatically and common hepatic duct emerged from the substance of liver at porta hepatis .

III. A. Types of union of cystic duct with common hepatic duct:

There are three types of union of cystic duct with common hepatic duct.(Table 2)

i **Angular type:** This type of union was observed in 150 specimens (75%), in the present study .

ii. Parallel type: 40 specimens (20%) were observed to be parallel type of union in this study.

iii. **Spiral type:** In the present study, 5% (10 cases) of the specimens were found to be of spiral type of union.

B. **Level of termination of cystic duct:** In the present series, normal level of union was observed in 172 (86%) specimens. High level union of cystic duct with common hepatic duct was noted in 8 specimens (4%). Low level union of cystic duct with common hepatic duct was noted in 20 cases (10%) of specimens of this study.

IV. Length of individual ducts: Table 1

V. Course and arrangement of structures in hepatoduodenal ligament: This normal arrangement was noted in 200/200 specimens.

VI. Variations in ductal system: The variations in the extrahepatic ductal system were observed under the following headings.

1. Presence of accessory ducts
2. Mode of termination of accessory ducts

By dissecting 200 specimens, a total of 2 accessory ducts were noted.

A. Accessory right hepatic ducts (total 2 cases):

I) In case No.80, presence of a small accessory right hepatic duct, arising close to inferior surface of gall bladder fossa was visualized.

ii) From case No.180, an accessory hepatic duct was seen emerging from the right lobe of liver. The accessory right hepatic duct was about 11.4 cms in length and was seen decending posterior and to the right of gall bladder . The frequency of occurrence of accessory ducts was 1% in this study.

Table 1: the length of the cystic duct, common hepatic duct, and common bile duct and accessory ducts(if present) in this study.

Case no.	Length of cystic duct(cms)	Length of common hepatic duct (cm)	Length of common bile duct(cm)	Length of accessary ducts (cm)
1.	4	3	4.8	
2.	2.6	3.2	6.5	
3.	3.3	3	7	
4.	3.5	3.5	6	
5.	3	2.5	5	
6.	2.5	3	5.5	
7.	1.5	2.5	6.5	
8.	3.8	2.2	7.5	
9.	3.5	3.2	6.8	
10.	3	3.4	7	
11.	2.2	3.5	5.6	
12.	2.4	2.5	6	
13.	2	3.6	6.2	
14.	2.5	3	5.6	
15.	2.8	2.4	5	
16.	3.5	2	5.5	
17.	3.8	2.8	7.3	
18.	3	2	7.0	
19.	3.4	2.7	5.2	
20.	2.6	2.2	4.4	
21.	3.3	3	3.8	
22.	3.5	3.3	5.8	
23.	3	2.7	7.2	
24.	2.5	3.5	6.6	
25.	1.5	3	6.2	
26.	3.8	3.2	6	
27.	3.5	3	8.4	
28.	3	3.5	4.5	
29.	2.2	2.5	5.8	
30.	2.4	3	7.4	
31.	2	2.5	4.8	
32.	2.5	2.2	6.5	
33.	2.8	3.2	7	
34.	3.5	3.4	6	
35.	3.8	3.5	5	
36.	3	2.5	5.5	
37.	4.2	3.6	6.5	
38.	2.6	3	7.5	
39.	3.3	2.4	6.8	

Case no.	Length of cystic duct(cms)	Length of common hepatic duct (cm)	Length of common bile duct(cm)	Length of accessary ducts (cm)
40.	3.5	2	7	
41.	3	2.8	5.6	
42.	2.5	2	6	
43.	1.5	2.7	6.2	
44.	3.8	2.2	5.6	
45.	3.5	3	5	
46.	3	3.3	5.5	
47.	2.2	2.7	7.3	
48.	2.4	3.5	7.0	
49.	2	3	5.2	
50.	2.5	3.2	4.4	
51.	2.8	3	3.8	
52.	3.5	3.5	5.8	
53.	3.8	2.5	7.2	
54.	3	3	6.6	
55.	4	2.5	6.2	
56.	2.6	2.2	6	
57.	3.3	3.2	8.4	
58.	3.5	3.4	4.5	
59.	3	3.5	5.8	
60.	2.5	2.5	7.4	
61.	1.5	3.6	4.8	
62.	3.8	3	6.5	
63.	3.5	2.4	7	
64.	3	2	6	
65.	2.2	2.8	5	
66.	2.4	2	5.5	
67.	2	2.7	6.5	
68.	2.5	2.2	7.5	
69.	2.8	3	6.8	
70.	3.5	3.3	7	
71.	3.8	2.7	5.6	
72.	3	3.5	6	
73.	4	3	6.2	
74.	2.6	3.2	5.6	
75.	3.3	3	5	
76.	3.5	3.5	5.5	
77.	3	2.5	7.3	
78.	2.5	3	7.0	
79.	1.5	2.5	5.2	
80.	3.8	2.2	4.4	4.8
81.	3.5	3.2	3.8	

Case no.	Length of cystic duct(cms)	Length of common hepatic duct (cm)	Length of common bile duct(cm)	Length of accessary ducts (cm)
82.	3	3.4	5.8	
83.	2.2	3.5	7.2	
84.	2.4	2.5	6.6	
85.	2	3.6	6.2	
86.	2.5	3	6	
87.	2.8	2.4	8.4	
88.	3.5	2	4.5	
89.	3.8	2.8	5.8	
90.	3	2	7.4	
91.	4	2.7	4.8	
92.	2.6	2.2	6.5	
93.	3.3	3	7	
94.	3.5	3.3	6	
95.	3	2.7	5	
96.	2.5	3.5	5.5	
97.	1.5	3	6.5	
98.	3.8	3.2	7.5	
99.	3.5	3	6.8	
100.	3	3.5	7	
101.	2.2	2.5	5.6	
102.	2.4	3	6	
103.	2	2.5	6.2	
104.	2.5	2.2	5.6	
105.	2.8	3.2	5	
106.	3.5	3.4	5.5	
107.	3.8	3.5	7.3	
108.	3	2.5	7.0	
109.	4	3.6	5.2	
110.	2.6	3	4.4	
111.	3.3	2.4	3.8	
112.	3.5	2	5.8	
113.	3	2.8	7.2	
114.	2.5	2	6.6	
115.	1.5	2.7	6.2	
116.	3.8	2.2	6	
117.	3.5	3	8.4	
118.	3	3.3	4.5	
119.	2.2	2.7	5.8	
120.	2.4	3.5	7.4	
121.	2	3	4.8	
122.	2.5	3.2	6.5	
123.	2.8	3	7	
124.	3.5	3.5	6	

Case no.	Length of cystic duct(cms)	Length of common hepatic duct (cm)	Length of common bile duct(cm)	Length of accessary ducts (cm)
125.	3.8	2.5	5	
126.	3	3	5.5	
127.	4	2.5	6.5	
128.	2.6	2.2	7.5	
129.	3.3	3.2	6.8	
130.	3.5	3.4	7	
131.	3	3.5	5.6	
132.	2.5	2.5	6	
133.	1.5	3.6	6.2	
134.	3.8	3	5.6	
135.	3.5	2.4	5	
136.	3	2	5.5	
137.	2.2	2.8	7.3	
138.	2.4	2	7.0	
139.	2	2.7	5.2	
140.	2.5	2.2	4.4	
141.	2.8	3	3.8	
142.	3.5	3.3	5.8	
143.	3.8	2.7	7.2	
144.	3	3.5	6.6	
145.	4	3	6.2	
146.	2.6	3.2	6	
147.	3.3	3	8.4	
148.	3.5	3.5	4.5	
149.	3	2.5	5.8	
150.	2.5	3	7.4	
151.	1.5	2.5	4.8	
152.	3.8	2.2	6.5	
153.	3.5	3.2	7	
154.	3	3.4	6	
155.	2.2	3.5	5	
156.	2.4	2.5	5.5	
157.	2	3.6	6.5	
158.	2.5	3	7.5	
159.	2.8	2.4	6.8	
160.	3.5	2	7	
161.	3.8	2.8	5.6	
162.	3	2	6	
163.	4	2.7	6.2	
164.	2.6	2.2	5.6	
165.	3.3	3	5	
166.	3.5	3.3	5.5	
167.	3	2.7	7.3	

Case no.	Length of cystic duct(cms)	Length of common hepatic duct (cm)	Length of common bile duct(cm)	Length of accessary ducts (cm)
168.	2.5	3.5	7.0	
169.	1.5	3	5.2	
170.	3.8	3.2	4.4	
171.	3.5	3	3.8	
172.	3	3.5	5.8	
173.	2.2	2.5	7.2	
174.	2.4	3	6.6	
175.	2	2.5	6.2	
176.	2.5	2.2	6	
177.	2.8	3.2	8.4	
178.	3.5	3.4	4.5	
179.	3.8	3.5	5.8	
180.	3	2.5	7.4	11.4
181.	4	3.6	4.8	
182.	2.6	3	6.5	
183.	3.3	2.4	7	
184.	3.5	2	6	
185.	3	2.8	5	
186.	2.5	2	5.5	
187.	1.5	2.7	6.5	
188.	3.8	2.2	7.5	
189.	3.5	3	6.8	
190.	3	3.3	7	
191.	2.2	2.7	5.6	
192.	2.4	3.5	6	
193.	2	3	6.2	
194.	2.5	3.2	5.6	
195.	2.8	3	5	
196.	3.5	3.5	5.5	
197.	3.8	2.5	7.3	
198.	3	3	7.0	
199.	3.5	2.5	5.2	
200.	3	2.2	4.4	

Table 2 - Types of Union of Cystic Duct with Common Hepatic duct

Author	Angular	Parallel	Spiral
Rugg(1908)	35%	20%	45%
Eisendrath(1918)	75%	17%	8%
Thompson (1933)	90%	6%	4%
A.Lurje (1937	46.9%	30.9%	22.2%
Edward (1952)	51.4%	31.4%	17.1%
Present Study (2011)	75%	20%	5%

Fig. 1 A case of accessory right hepatic duct terminating at a point of junction of CD and CHD. i.e. ARHD, CD and CHD joining at a common point.

Fig. 2: A Case of Accessory cystic artery arising from SMA.

Fig. 3: A case of abnormal cystic artery arising directly from common hepatic artery and crossing in front of common hepatic duct.

Fig. 4: A case of intrahepatic gall bladder.

Discussion

I. Formation of common hepatic duct:

Site of union of right and left hepatic ducts

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

Rugg (1908)[1] studied 43 cadavers. In that he observed extra hepatic union of right and left hepatic ducts in 79% and intrahepatic union of right and left hepatic ducts in 21%. **Eisendrath**[2] (1918) also observed 100% union of extra hepatic right and left hepatic ducts from 100 specimens. **Thompson**[3] dissected 50 specimens in 1933 and noted 90% extra hepatic union and 10% intrahepatic union of right and left hepatic ducts.

In the present study on 200 specimens extra hepatic union of right and left hepatic ducts was noted in 70% of cases and intrahepatic union of right and left hepatic ducts in 30% of cases.

II A). Types of union of cystic duct with common hepatic duct: (Table 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 are noted namely,

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

B. Level of termination of cystic duct: The levels of termination of cystic duct with common hepatic ducts are:

1. High level
2. Low level
3. Normal level

Hossein Mahour[4] in (1961), from a study on 100 autopsies, described about the height of termination of cystic duct. In that, in 80% of cases cystic duct runs obliquely to join common hepatic duct. In 18% of cases low level of union and in 1.5% of cases high level of union was noted. In the present study, normal level of union of cystic duct with common hepatic duct was visualized in 86% (172) of cases. Hence the present study coincides with that of Hossein Mahour[4] in terms of normal level of union but not regarding high and of low level of union.

III. Length of individual ducts:

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

Edward V. Johnston[6] (1952) by measuring 35 specimens gave the length of cystic duct as 2.9cms and length of common bile duct as 6.6cms.

Gray's anatomy[7] (2008), mentioned the average length of cystic duct is 3 - 4 cm. length of common hepatic duct is 3 cm and the length of common bile duct is 7.5 cms. Present study (2013): The average length of cystic duct was 2-4 cms. The average length of common hepatic duct was 2-3 cms. The average length of common bile duct was 6-8 cms.

IV. Course and arrangement of structures in hepatoduodenal ligament: In present study, the arrangement of structures was observed to be the same as mentioned by Hollinshead except in 2.5% of cases in which the common bile duct lies anterior and to the right in the actual edge of hepatoduodenal ligament.

1. Variations in Ductal system:

The variations in ductal system can be discussed under the following headings.

1. Presence of accessory hepatic or cystic ducts
2. Mode of termination of accessory hepatic or cystic ducts

Presence of accessory hepatic or cystic ducts: Schachner[8] (1916) studied 76 specimens in

which he noted, double cystic duct in 2 cases & absence of common bile duct in 1 case. In present study, accessory cystic duct (Double cystic duct) was not noted in any specimens. **Flint**[9] (1922 - 23) described about 29 (14.5%) accessory bile ducts by dissecting 200 specimens. All were accessory right hepatic ducts. **Gray** (1938) [10] stated that accessory hepatic ducts are more common from right lobe of liver. **Edward H. Daseler** (1947)[11] worked on 500 cases and visualized, accessory right hepatic duct in 8 cases (1.6%). In this study (2013), we observed in 1% (2 cases) accessory hepatic ducts issuing from the right lobe of liver (**Figure 1)** i.e. ARHD, CD and CHD joining at a common point. On comparing the above studies the present study coincides with that of Edward regarding the presence of accessory right hepatic duct

Mode of Termination of Duct: Flint (1922 - 23)[9] dissected 200 specimens. He classified 29 accessory bile ducts on the basis of termination as:

	Flint study	Present study
Junction occurs in upper 1/2 of common hepatic duct (or) in right hepatic duct - High Union	4.5	nil

Junction occurs in lower 1/2 of common hepatic duct	4.5	Nil
Junction at the union of cystic and common hepatic duct	5	0.5

The present study coincides with the above study except in termination at the union of cystic and common hepatic duct, but I have also encounter accessory right hepatic duct draining in the middle of common hepatic in 5% of cases. Edward H. Daseler (1947)[11] in his work on 500 cases showed.

	Daseler study	Present study
Accessory right hepatic duct entered common bile duct	0.2%	0.5%
Accessory right hepatic duc entered cystic duct	0.6%	Nil
Small accessory right hepatic duct draining into gall bladder	0.4%	Nil

On comparing the above study, it correlates with that of Edward Daseler[11] study but, the occurrence is more in the present study and it disagrees with the finding that accessory right hepatic duct draining into gall bladder.

V Variations in arterial system in relation to the duct system:

The two main arteries related to the duct system are cystic artery and right hepatic artery. These two arteries are discussed under the following headings.

1. Origin of the artery
2. Relation of the artery to common hepatic duct

a. Origin of Cystic Artery:

	Flint study	Present study
Origin from right hepatic artery	98%	94%
Origin from left hepatic artery	1.5%	Nil
Origin from gastro duodenal artery	0.5%	Nil

The present study coincides with Flint's finding except for cystic artery origin from left hepatic artery and gastro duodenal artery. Edward H. Daseler (1947)[11] from a study of 500 specimens, classified the various origins of cystic artery into 12 types.

	Daseler study	Present study
Accessory right hepatic duct entered common bile duct	0.2%	0.5%
Accessory right hepatic duc entered cystic duct	0.6%	Nil
Small accessory right hepatic duct draining into gall bladder	0.4%	nil

But, on comparing all the above studies including the present study, cystic artery arising from right hepatic artery is noted to be the commonest one.

b.Accessory cystic artery:

Flint (1922 - 23)[9] 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 gastro duodenal artery and 3.2% (1) from superior pancreaticoduodenal artery. Edward H. Daseler (1947)[11] worked in 580 lab specimens and noted in 65 specimens, accessory cystic artery. In this, in 76.9% cases it arises from right hepatic artery, 6.15% cases from common hepatic artery and 3% cases from accessory right hepatic branch of superior mesenteric artery. In present study (2013), we have noted accessory cystic artery in 4% of cases from a study on 200 specimens in which it arises from common hepatic artery. **(Figure 2)**

c. **Double cystic artery:** The presence of double cystic artery observed in the present study was 2%.

d. **Origin of right hepatic artery:**

Flint (1922 - 23)[9] from his work on 200 specimens showed,

	Flint study	Present study
right hepatic artery arising from main hepatic artery	79	96
from superior mesenteric artery	21	2
presence of 2 right hepatic arteries one from hepatic proper and other from superior mesenteric artery	3.5	1
presence of 2 right hepatic arteries both from hepatic proper	0.5	1

Present study coincides with that of Flint's[9] study in origin of right hepatic artery. **Edward H. Daseler** (1947)[11] dissected 500 specimens and reported,

right hepatic artery arising from	Daseler study	Present study
Hepatic artery proper	83.2	96
Replacing type of right hepatic artery from superior mesenteric artery	11.2	Nil
Accessory right hepatic artery from superior mesenteric artery	3	1

Both the studies coincide, except that right hepatic artery origin from replacing type of right hepatic artery derived from superior mesenteric artery which showed less in occurrence.

Hence, on comparing all the above studies including the present study we observed right hepatic artery arising from hepatic proper is the commonest one.

2. Relationship of arteries to common hepatic duct:

a. Cystic artery in relation to common hepatic duct:

Flint (1922 - 23)[9] dissected 200 specimens and stated,

	Flint study	Present study
cystic artery passing in front of common hepatic duct	16	10
cystic artery passing behind common hepatic duct	84	90

The present study correlates with that of Flint study (**Figure 3)**

Edward H. Daseler (1947)[11] observed 580 laboratory specimens and described.

	Daseler study	Present study
cystic artery crossing anterior tocommon hepatic duct	21.2	10
cystic artery crossing posterior to common hepatic	2	90

On comparing the above study the anterior relationship of the artery to common hepatic duct is found to be high in number in the author's study, which is highly contradictory to present study. Since in the present study we encounter posterior relationship to the artery is more as number.

Right Hepatic Artery in Relation to Common Hepatic Duct:

Flint (1922 - 23)[9] in his work on 200 specimens showed,

	Flint study	Present study
Right hepatic artery passing posterior to common hepatic duct	68	90
Right hepatic artery passing anterior to common hepatic duct	12.5	8

Edward H. Daseler (1947)[11] on 580 cases noted,

	Daseler study	Present study
Right hepatic artery crossing dorsal to common hepatic duct	65	90
Right hepatic artery passing ventral to common hepatic duct	11.6	8
Right hepatic artery passing entirely to the left side of duct	1.6	1

On comparing the above studies, the posterior relationship of right hepatic artery to the common hepatic duct is found to be more in occurrence. Hence present study coincides with Flint, Edward in this aspect. But the anterior relationship of right hepatic artery with common hepatic duct was observed in 8% of cases, which is significantly less in number when compared to the above studies.

Conclusion

Extra hepatic union of right and left hepatic ducts to form the common hepatic duct was noted in 72% of cases, which appeared to be more common than intrahepatic union.

Cystic duct joins the common hepatic duct as angular type of union in 75% of cases.

The average length of the ducts observed in the study are Cystic duct 2-4 cms, common hepatic duct 2-3 cms and common bile duct 5-8 cms. The arrangement of structures in hepatoduodenal ligament was that, common bile duct lies anterior and to the left of the ligament, hepatic artery lies anterior and to the left of duct system and portal vein larger and posterior to these structures. The frequency of occurrence of accessory ducts was 1 %.

The most commonly occurring ductal variations are presence of accessory right hepatic ducts terminating anywhere in common hepatic duct or by a seperate opening in duodenum directly.

Cystic artery arising from the coeliac right hepatic artery is seen inside the calot's triangle is noted to be the commonest arrangement. Right hepatic artery arises from hepatic

proper and seen to the left side of duct system. Both cystic and right hepatic arteries passing posterior to the common hepatic duct to reach the calot's triangle is seen to be more common. Hence, many variations have established in this region and understanding of these variations is undoubtedly important for operating surgeons. Starting from open cholecystectomy or laparoscopic cholecystectomy to cadaveric liver harvesting to recent advances like "Living donor liver transplantation with duct to duct anastomosis" (LDLT), grading of tumours like hilar cholangiocarcinoma, requires definitive knowledge of the anatomy of the ductal and arterial system. Hence, We believe this study is not only confined to anatomists, but definitely be a useful guideline for general and laparoscopic surgeons, oncosurgeons and to transplant surgeons.

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