STUDY OF SITE AND TYPE OF UNION OF BILIARY DUCTS

Leena Ammini Bhaskaran¹, Romi Sadanandan²¹Assistant Professor, Department of Anatomy, Government Medical College, Thiruvananthapuram.²Professor and HOD, Department of Anatomy, Government Medical College, Thiruvananthapuram.

ABSTRACT

BACKGROUND

The study of angle of union of biliary ducts is of great importance to the hepatobiliary surgeons. The union of cystic and common hepatic duct can be angular, spiral or parallel. The site of union can be average, high or low.

MATERIALS AND METHODS

Study was conducted on 250 specimens (Cadaveric, Autopsy and Foetal) in Government Medical College, Thiruvananthapuram, for 2 years. Site and type of union was observed.

RESULTS

Type 1 or angular union of ducts was most common. Low union of ducts was seen in majority.

CONCLUSION

Knowledge of anatomy of biliary ducts is important for hepatobiliary surgeons, as the variations are very common and can cause complications during surgery.

KEYWORDS

Cystic, Common Hepatic, Duct, Type, Site.

HOW TO CITE THIS ARTICLE: Bhaskaran LA, Sadanandan R. Study of site and type of union of biliary ducts. J. Evolution Med. Dent. Sci. 2017;6(62):4534-4538, DOI: 10.14260/Jemds/2017/981

BACKGROUND

The right and left hepatic ducts arising from the liver unite as the common hepatic duct, joins the cystic duct at an acute angle to form the common bile duct. The bile duct approaches the pancreatic duct; unite to form the hepatopancreatic ampulla, which opens on the summit of major duodenal papilla.

According to the type of junction formed by common hepatic duct and cystic duct, there may be greater or lesser risk of injury of these structures during surgical interventions or pathological processes. In normal individual, anomalies in this region does not create any medical emergencies, but it may produce significant complications following the surgeries pertaining to this region.

The manner of junction of cystic and common hepatic duct was cited in LH Blumgart's¹ 'Surgery of liver, biliary tract and pancreas.' The modes of union may be 3 types- angular, parallel and spiral. Angular union is most frequent and is found in 75% patients. The cystic duct may run a parallel course to common hepatic duct in 20% with connective tissue ensheathing both ducts. Finally, cystic duct may approach common bile duct in a spiral fashion. It could be anterior spiral or posterior spiral. Variations of gallbladder, hepatic, cystic and bile ducts were reported by Johnston EV and

Anson BJ² in 1952 after detailed dissections of hepatoduodenal ligament in thirty-five cadavers. Julian A Sterling³ in 1955 studied the angle of union of cystic and common hepatic ducts.

In some people, there is low union of cystic and common hepatic duct. As a result, bile duct is short and lies posterior to first part of duodenum or even below it. When there is low union, two ducts may be joined by fibrous tissue making surgical clamping of cystic duct difficult without injuring common hepatic duct. Occasionally, there is high union of cystic and common hepatic ducts near porta hepatis.

Anatomical study of junction of cystic duct and common hepatic duct in 33 fetuses was done by Santiago MS, Santiago TS⁴ et al in 2003. Keizman D, Shalom MI⁵ et al in 2006 studied angulation of common bile duct, which predisposes to recurrent symptomatic bile duct stones after endoscopic stone extraction. Gulzari Lal Nigam⁶ et al in 2014 studied the biliary ducts in 59 individuals undergoing hepatobiliary surgery and in 30 cadavers.

MATERIALS AND METHODS

Study design was descriptive. The number of specimens required was calculated based on the formula-

$$n = \frac{1.96^2 \times p \times q}{L^2}$$

The least variation observed was in angulation of ducts, which is 37% according to the study of Johnston EV and Anson BJ² in 1952 in "Variations in the formation and vascular relations of bile ducts."

$$\begin{aligned} L &= 37 \times 20 / 100 = 7.4 \\ n &= \frac{1.96^2 \times 37 \times 63}{7.4 \times 7.4} \sim 180 \end{aligned}$$

Financial or Other, Competing Interest: None.

Submission 28-06-2017, Peer Review 22-07-2017,

Acceptance 28-07-2017, Published 03-08-2017.

Corresponding Author:

Dr. Leena Ammini Bhaskaran,

Aswathy, Koora-40,

Koottamvila Road,

Vattiyoorkavu P. O.,

Trvandrums-13.

E-mail: ableena@gmail.com

DOI: 10.14260/Jemds/2017/981

The foetuses with anomaly was 10 out of 15 as per the study. "Extrahepatic biliary passages: an anatomical study in full-term human foetuses" by Girijakumari K⁷ in 1990. This comes to 66%.

$L = 66 \times 20 / 100$.

$$n = \frac{1.96^2 \times 66 \times 34}{13.2 \times 13.2} \sim 50$$

The study was conducted on 20 cadavers in Anatomy Department, 160 autopsies in Department of Forensic Medicine in Government Medical College, Trivandrum. Around 50 foetal specimens were obtained during foetal autopsies conducted by Pathology Department. Abdominal wall was reflected in cadavers. Peritoneum is incised similarly and abdominal cavity exposed. Greater omentum was identified. Coeliac trunk and origin of right hepatic artery was noted. Stomach was removed by double ligatures. Careful dissection of hepatobiliary region was carried out. Measurements were done using vernier calipers with an accuracy of 0.01 mm. Angles were measured using protractor.

Types of Union of Cystic and Common Hepatic Ducts were Classified as-

- Type 1 - Normal angular union.
- Type 2A - Joins anterior to common hepatic duct.
- Type 2P - Joins posterior to common hepatic duct.
- Type 3 - Short parallel 10 – 25 mm.
- Type 4 - Long parallel > 25 mm.
- Type 5 - Anterior spiral union.
- Type 6 - Posterior spiral union.

RESULTS

Average angle of union of cystic and common hepatic duct in present study was 42.5 ± 0.89 degrees (Table 1). Angle between hepatic ducts was 111.1 ± 4.82 . Angle between common bile duct with vertical was 36.7 ± 0.57 degrees.

Angle	Average	Value		Sd
Angle 1	60-120	111.1	+	4.82
Angle 2	0-94	42.5	+	0.89
Angle 3	16-52	36.7	+	0.57

Table 1. Angle between Ducts

Angle 1- Angle between right hepatic duct, left hepatic duct.
Angle 2- Angle between cystic duct and common hepatic duct.
Angle 3- Angle between common bile duct with vertical.

Union Right and Left Hepatic Ducts	Number	%
Extrahepatic	5	2.2
Intrahepatic	225	97.8
Total	230	100.0

Table 2. Union of Right and Left Hepatic Ducts

Majority of hepatic ducts had intrahepatic union.

Site and Type of Union of Cystic and Common Hepatic Duct	Number	%
Average, Type 1	48	20.8
Average, Type 2A	6	2.6
Average, Type 2P	1	.4
Average, Type 3	6	2.6

Average, Type 4	4	1.7
Average, Type 5	8	3.5
Average, Type 6	8	3.5
High, Type 1	22	9.5
High, Type 2A	1	.4
High, Type 2P	3	1.3
High, Type 3	5	2.2
High, Type 4	4	1.7
High, Type 5	5	2.2
High, Type 6	5	2.2
Low, Type 1	53	23
Low, Type 2A	9	3.9
Low, Type 2P	7	3.0
Low, Type 3	7	3.0
Low, Type 4	3	1.3
Low, Type 5	11	4.8
Low, Type 6	12	5.6
NIL	1	.4
Very High Type 1	1	.4
Total	230	100.0

Table 3. Site and Type of Union of Cystic and Common Hepatic Duct

Site of Union	Number	%
Average	81	35.2
High	46	20
Low	102	44.4
NIL	1	.4
Total	230	100.0

Table 4. Level of Union of Cystic and Common Hepatic Duct

Low union of cystic duct and common hepatic duct was more common followed by average union. The least was low union of ducts.

Type of Union	Number	%
Nil	1	.4
Type 1	123	53.5
Type 2A	16	7
Type 2P	11	4.8
Type 3	18	7.8
Type 4	11	4.8
Type 5	24	10.4
Type 6	26	11.3
Total	230	100.0

Table 5. Type of Union of Cystic and Common Hepatic Duct

Various types of union of biliary ducts are shown in Table 5. Angular union of ducts was most common.

Chart 1. Type of Union of Cystic and Common Hepatic Duct

Duct		Number	Mean	SD	Standard Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Left Hepatic Duct	Nil	1	1.200					1.2	1.2
	Average	81	1.578	.6971	.0775	1.424	1.732	.2	2.6
	Low	103	1.651	.7204	.0710	1.511	1.792	.5	3.6
	High	46	1.513	.6797	.1002	1.311	1.715	.3	3.4
	Total	231	1.596	.7023	.0462	1.505	1.687	.2	3.6
Right Hepatic Duct	Nil	1	.800					.8	.8
	Average	81	1.269	.5463	.0607	1.148	1.390	.2	2.5
	Low	103	1.384	.6014	.0593	1.267	1.502	.2	3.2
	High	46	1.235	.5693	.0839	1.066	1.404	.4	3.2
	Total	231	1.312	.5770	.0380	1.237	1.386	.2	3.2
Cystic Duct	Nil	1	.000					.0	.0
	Average	81	2.127	1.0090	.1121	1.904	2.350	.3	4.0
	Low	103	2.434	.9968	.0982	2.239	2.629	.6	4.2
	High	46	1.907	.9034	.1332	1.638	2.175	.4	4.2
	Total	231	2.211	1.0094	.0664	2.080	2.342	.0	4.2
Common Hepatic Duct	Nil	1	.000					.0	.0
	Average	81	2.021	1.0092	.1121	1.798	2.244	.4	4.0
	Low	103	2.193	1.0433	.1028	1.989	2.397	.4	5.0
	High	46	1.798	.9919	.1462	1.503	2.092	.4	5.0
	Total	231	2.045	1.0343	.0681	1.910	2.179	.0	5.0
Common Bile Duct-Total	Nil	1	3.900					3.9	3.9
	Average	81	6.867	3.5510	.3946	6.081	7.652	1.1	10.8
	Low	103	6.804	3.2240	.3177	6.174	7.434	1.0	11.4
	High	46	7.215	3.8037	.5608	6.086	8.345	1.3	11.5
	Total	231	6.895	3.4482	.2269	6.448	7.342	1.0	11.5

Table 6. Comparison between Level of Union of Ducts and Length of Ducts

Chart 2

There is no significant difference in the mean values of the above variables among those with average type and high type. However, mean length of cystic duct and common hepatic duct was significantly higher for low type when compared to high type (See Table 11). Common bile duct was longer in high type comparatively.

Similarly, there was no significant difference in the mean values of these variables among average type and low type.

Figure 1. Middle Hepatic Artery, Average, Angular Union of Cystic Duct with Common Hepatic Duct

MHA - Middle hepatic artery.
CHA - Common hepatic artery.

Figure 2. Low and Long Parallel Type of Union of Cystic and Common Hepatic Ducts, Moynihan's Hump

- HAP - Hepatic artery proper.
 CHA - Common hepatic artery.
 GDA - Gastrooduodenal artery.
 CALOT - Calot's triangle.
 MYH - Moynihan's hump.

Figure 3. Anterior Spiral Type of Union of Cystic and Common Hepatic Ducts

- PV - Portal vein.
 Ant. Spiral Union - Anterior spiral union.

Figure 4. Right Hepatic Artery between Right Hepatic and Left Hepatic Ducts, Posterior Spiral Union of Cystic and Common Hepatic Ducts, Cystic Artery Anterior to Right Hepatic Duct

- LHA - Left hepatic artery.
 POST SPIRAL - Posterior spiral union.

DISCUSSION

The angle of union of cystic and common hepatic duct is highly variable. Average angle of union was 42.5 ± 0.89 degrees (Table 1). Congenital absence of cystic duct was reported in a 1-year-old male child with agenesis of gallbladder.

Common variations in union of cystic and common hepatic ducts are angular, parallel and spiral. Parallel was classified into short parallel, where the 2 ducts join together for 10 – 25 mm and then unite. Long parallel type is where cystic and common hepatic ducts join together for more than 25 mm and then unite.

Normal angular union (Fig. 1) of cystic duct joining the right side of common hepatic duct at acute angle was seen in 65.4%, which was less than reported by Moosman and Coller,⁸ Johnston EV,² Julian A Sterling,³ Tamol Limthanakhom⁹ and Santiago,⁴ but more than Ruge, Kunze and Eisendrath.¹⁰ Angular union was 94% in the study by Gulzar Lal Nigam.⁶ Angular junction with the anterior aspect of common hepatic duct (Fig. 1) was found in 6.9% and posterior aspect of common hepatic duct in 4.8%. This was more compared to Hayes,¹¹ who found 0.75% anterior and 0.5% posterior union of ducts.

Short parallel (5 – 7 cm) type of union was more common, which agrees with Thompson.¹² Short parallel (10 – 25 mm) was seen in 4.3% which was less compared to Moosman (15.2%), whereas long parallel (> 25 mm) was seen in 8.2% which was more compared to Moosman⁸ (4.4%). In the long parallel type if cystic duct is ligated too close to the common hepatic duct, it can undergo strictures or narrowing at this site.

Total parallel ducts noted in our study was 12.55%, which was more than Tamol Limthanakhom⁹ -8.3%, Gulzar Lal Nigam⁶ -4% and less than Johnston EV² -20%, Ruge -29%, Eisendrath -17%, Santiago⁴ -29% and Hand¹³ -25%.

Anterior spiral union (Fig. 3) was seen in 10.44% in the present study, more than Moosman and Coller (4%) and posterior spiral (Fig. 4) in 11.3% which was more compared to Moosman and Coller⁸ (1.2%). Spiral union in present study (both anterior and posterior) was 21.7%, which was more than Hand¹⁴ -10%, Moosman and Coller⁸ -5.2%, Johnston EV² -17.1%, Kunze -0%, Julian A Sterling³ -8%, Tamol Limthanakhom⁹ 6.3%, Gulzar Lal Nigam⁶ -8% and less than Ruge -38%. Our study agrees with McWhorter¹⁵ and Thompson,¹⁴ in that posterior spiral union is more common than anterior spiral union.

Site of joining of cystic duct at the anterior aspect of common hepatic duct (type 2A and type 5) was 16.5% in the present study, which was higher when compared to 4.2% Tamol⁹ and 1.5% by Hayes.¹³ The present study reported 11.3% having posterior junction with the common hepatic duct, which was also greater than that observed by (0%) Tamol⁹ and (1%) by Hayes.¹³

Variations in the position of junction of cystic and common hepatic ducts were studied. The insertion was found to be average (Fig. 1) type in 35.1%, less than 45.2% by Santiago MS, high type in 19.9%, less than 29% by Santiago MS and low type (Fig. 2) in 44.6% which was more than 25.8% by Santiago⁴ MS. Among the anatomical variations, low union was most common in the present study which disagrees with Santiago MS who found that average insertion was most common.

Low insertion of cystic duct was associated with high rate of common bile duct stone formation. Failure to identify a low insertion of cystic duct may result in technical difficulties during ERCP procedures.

The length of cystic and common hepatic duct was greatest in low union, intermediate in average union, least in high union and length of common bile duct was maximum in high union, least in low union of ducts which strongly agrees with Santiago⁴ MS.

Intrahepatic union (97.8%) of right hepatic and left hepatic ducts was more common in the present study. This agrees with Cole and Associates with 90% intrahepatic union, but disagrees with Thompson who reported 91% extrahepatic union. According to study by Gulzari Lal Nigam, all union were extrahepatic.³

CONCLUSION

The anatomy of the extrahepatic biliary apparatus is highly variable and some of these variations and anomalies can be problematic for surgeons during surgical procedures such as laparoscopic cholecystectomy, liver resection and living donor transplantation. Surgery if not done carefully result in major complications such as leakage of ducts or atrophy of liver. Therefore, it is important to have a thorough knowledge in successful detection and recognition of such anatomic variations, thereby decreasing morbidity and mortality rates during hepatobiliary surgery.

REFERENCES

- [1] Blumgart LH, Fong Y. Surgery of the liver and biliary tract. 3rd edn. Vol 1, WB Saunders, London 2000:1639-715.
- [2] Johnston EV, Anson BJ. Variations in the formation and vascular relationship of the bile ducts. *Surg Gynaec Obstet* 1952;94(6):669-86.
- [3] Sterling JA. The biliary tract. Williams and Wilkins 1955:46-56.
- [4] Santiago MS, Santiago TS, Melo VA, et al. Anatomic study of variations in the position of the junction of the cystic and common hepatic ducts in fetuses. *Acta Cir Bras* 2003;18(1).
- [5] Keizman D, Shalom MI, Konikoff FM. An angulated common bile duct predisposes to recurrent symptomatic bile duct stones after endoscopic stone extraction. *Surg Endosc* 2006;20(10):1594-9.
- [6] Nigam GL, Lalwani R, Babu CSR, et al. Surgical anatomy of sub-hepatic biliary system. *JASI* 2014;63:48-51.
- [7] Girijakumari K. Extrahepatic biliary passages: an anatomical study in full term human fetuses. University of Kerala 1990:35-48.
- [8] Moosman DA, Collier FA. Prevention of traumatic injury to the bile ducts; a study of the structures of the cystohepatic angle encountered in cholecystectomy and supraduodenal choledochostomy. *Am J Surg* 1951;82(1):132-43.
- [9] Limthanakhom T, Khamanarong K, Bhudhisawasdi V. The anatomical variations of cystic duct in northeastern Thai population. *The Thai Journal of Surgery* 2005;26(3):73-7.
- [10] Eisendrath DN. Anomalies of the bile ducts and blood vessels. *JAMA* 1918;71(11):864-7.
- [11] Hayes MA, Goldenberg IS, Bishop CC. The developmental basis for bile duct anomalies. *Surg Gynaec Obstet* 1976;107(4):447-56.
- [12] Thompson IM. On the arteries and ducts in the hepatic pedicle: a study in statistical human anatomy. *Univ of California Pub Anat* 1933;1:55-160.
- [13] Hand BH. Anatomy and function of the extrahepatic biliary system. *Clin Gastroenterol* 1973;2(1):3-29.
- [14] McWhorter GL. A new method of gallbladder dissection with a consideration of the surgical anatomy. *Surg Gynaec Obstet* 1923;36:256-63.
- [15] Cole WH. Congenital anomalies of the bile ducts and adjacent blood vessels. *Surg Gynaec Obstet* 1948;87(1):111-2.