STUDY OF SITE AND TYPE OF UNION OF BILIARY DUCTS

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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.


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’s: ‘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 Sterling2 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 hepatitis.

Anatomical study of junction of cystic duct and common hepatic duct in 33 foetuses 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:"

\[ L = \frac{37 \times 20}{100} = 7.4 \]
\[ n = \frac{1.96^2 \times 37 \times 63}{7.4} \approx 180 \]
Majority of hepatic ducts had intrahepatic union.

\[ n = 1.96^2 \times 66 \times 34 \approx 50 \]

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.

<table>
<thead>
<tr>
<th>Angle</th>
<th>Average</th>
<th>Value</th>
<th>Sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle 1</td>
<td>60-120</td>
<td>111.1</td>
<td>+ 4.82</td>
</tr>
<tr>
<td>Angle 2</td>
<td>0-94</td>
<td>42.5</td>
<td>+ 0.89</td>
</tr>
<tr>
<td>Angle 3</td>
<td>16-52</td>
<td>36.7</td>
<td>+ 0.57</td>
</tr>
</tbody>
</table>

### 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.

### Table 2. Union of Right and Left Hepatic Ducts

<table>
<thead>
<tr>
<th>Union Right and Left Hepatic Ducts</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrahepatic</td>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>Intrahepatic</td>
<td>225</td>
<td>97.8</td>
</tr>
<tr>
<td>Total</td>
<td>230</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Majority of hepatic ducts had intrahepatic union.

<table>
<thead>
<tr>
<th>Site and Type of Union of Cystic and Common Hepatic Duct</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average, Type 1</td>
<td>48</td>
<td>20.8</td>
</tr>
<tr>
<td>Average, Type 2A</td>
<td>6</td>
<td>2.6</td>
</tr>
<tr>
<td>Average, Type 2P</td>
<td>1</td>
<td>.4</td>
</tr>
<tr>
<td>Average, Type 3</td>
<td>6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

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

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.

### 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.
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.
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,1 more but 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 cm) was seen in 4.3% which was less compared to Moosman (15.2%), whereas long parallel (>25 cm) was seen in 8.2% which was more compared to Moosman (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 Coller (1.2%). Spiral union in present study (both anterior and posterior) was 21.7%, which was more than Hand14 -10%, Moosman and Coller5 -5.2%, Johnston EV2 -17.1%, Kunze -0%, Julian A Sterling3 -8%, Tamol Limthanakhom9 6.3%, Gulzar Lal Nigam6 -9% 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% Tamol6 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%) Tamol6 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 Santiago6 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.

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.

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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, least in low union of ducts which strongly agrees with Santiago 4 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