Normal Anatomy of Porta Hepatis—A Cadaveric Study

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Abstract

Background and Aim Porta hepatitis (PH) of the liver acts as a gateway for exit and entry of important structures like portal vein, hepatic artery, and hepatic duct. Having knowledge of variations about the dimensions and structures at PH becomes important to avoid complications during surgical and radiological interventions. Our study aims to observe the dimensions of PH and also the number, arrangement, and variations of structures passing through PH.

Materials and Methods Fifty adult cadaveric human livers which were preserved in formalin were studied. Transverse diameter, anteroposterior diameter, and circumference of PH were measured using vernier calipers, measuring scale, and thread. PH was carefully dissected to study the number, arrangement, and combination of arteries, veins, and ducts at PH.

Results The mean transverse diameter, anteroposterior diameter, and total circumference of PH was 3.17 ± 0.50, 1.68 ± 0.36, and 10.46 ± 1.415 cm, respectively. Eighteen specimens showed presence of two arteries, two veins, and one duct at PH. Maximum number of arteries, veins, and ducts passing through PH were 5, 4, and 1, respectively. The ducts were anterior, arteries in the middle, and veins were posterior in PH of all the livers.

Conclusion The variations observed in our study will be of great importance to anatomists, surgeons, and radiologists.

Keywords ► porta hepatis ► portal vein ► hepatic artery ► hepatic duct

Introduction

The liver is the largest gland and the most important organ in human body. It also performs an astonishingly large number of tasks that impact the whole body system. As the liver is involved in majority of the metabolic activities in the body, it is more likely to get affected by various pathological conditions.

Porta hepatitis (PH) is a transverse nonperitoneal fissure on the inferior surface which acts as a gateway of the liver. It extends from the neck of the gall bladder to the fissure for ligamentum teres and venosum, and intervenes between the quadrate lobe in the front and caudate process at the back. Although PH is nonperitoneal, its margins give attachment to lesser omentum. Hepatic artery with autonomic plexus around it and the portal vein (PV) enter the liver through PH. Lymphatics and the hepatic duct emerges out of the liver through PH.

PH transmits important neurovascular structures and hence it acquires great importance while carrying out clinical procedures like liver transplant, surgical interventions, and diagnostic radiological procedures which can be associated with complications. The “complex anatomic architecture” of the vascular and biliary structures at the PH makes it a surgically challenging area.1 Hence, a surgeon requires detailed knowledge of the normal anatomy of PH and structures related to it.

The present study aims in studying the dimensions, numerical variations, and arrangement of structures in PH. These findings will be of significance for anatomists, surgeons operating on this region, and radiologists to avoid iatrogenic complications.

Materials and Methods

The study was conducted at the Belagavi Institute of Medical Sciences, Belgaum, on 50 adult cadaveric human livers preserved in formalin of unknown sex. Ethical approval was
taken from the institutional ethical committee prior to the commencement of the study.

Specimens with any surface anomalies and pathologies were excluded from the study. On inferior surface PH was identified and the transverse diameter and anteroposterior diameter were measured using sliding vernier calipers. Total circumference was measured with a thread and confirmed with a measuring scale (see ►Fig. 1). Average of three measurements was recorded. The PH was carefully dissected and studied for number, arrangement, and combination of structures (►Figs. 2–6).

**Results**

In the present study, the transverse diameter and anteroposterior diameter of PH ranged from 2.4 to 4.5 cm to 1.0 to 2.6 cm. The mean ± standard deviation (SD) for transverse diameter and anteroposterior diameter were $3.17 \pm 0.50$ and $1.68 \pm 0.36$ cm, respectively. The minimum total circumference measured was 7.5 cm and the maximum was 12.8 cm with a mean ± SD of $10.46 \pm 1.415$ cm. The measurements are shown in ►Table 1.

►Table 2 shows various combinations of the structures passing through PH and their frequency of occurrence. The common combination in our study was two veins,
two arteries, and one duct which were seen in 36% of specimen followed by two veins, three arteries, and one duct in 22% and one vein, two arteries, and one duct in 20% of specimens.

The number of structures varied from one to five for arteries; 56% of specimens showed two arteries and one to four veins, 72% of specimens showed two veins, and 100% of specimens showed only one duct (►Figs. 2–6). Details for the number of structures passing through PH and their frequency of their occurrence are shown in ►Table 3.

The arrangement of structures in the PH was constant. The ducts were anterior, arteries in the middle, and veins were posterior in PH of all the livers.

**Table 1** Dimensions of porta hepatis

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Range (cm)</th>
<th>Mean and standard deviation (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse diameter of the porta hepatis</td>
<td>2.4–4.5</td>
<td>3.17 ± 0.50</td>
</tr>
<tr>
<td>Anteroposterior diameter of the porta hepatis</td>
<td>1.0–2.6</td>
<td>1.68 ± 0.36</td>
</tr>
<tr>
<td>Total circumference</td>
<td>7.5–12.8</td>
<td>10.46 ± 1.415</td>
</tr>
</tbody>
</table>

**Table 2** Various combinations of structures passing through porta hepatis and their frequency of occurrence

<table>
<thead>
<tr>
<th>Combination</th>
<th>Number of specimen (n = 50)</th>
<th>% of specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1V2A1D</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>2V3A1D</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>1V4A1D</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>2V1A1D</td>
<td>02</td>
<td>04</td>
</tr>
<tr>
<td>2V2A1D</td>
<td>18</td>
<td>36</td>
</tr>
<tr>
<td>2V4A1D</td>
<td>04</td>
<td>08</td>
</tr>
<tr>
<td>1V3A1D</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>2V5A1D</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>1V1A1D</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>4V2A1D</td>
<td>01</td>
<td>02</td>
</tr>
</tbody>
</table>

Abbreviations: A, artery; D, duct; V, vein.

**Table 3** Number of each structures passing through porta hepatis and frequency of their occurrence

<table>
<thead>
<tr>
<th>Number of structures</th>
<th>Number of specimen (n = 50)</th>
<th>% of specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 artery</td>
<td>04</td>
<td>08</td>
</tr>
<tr>
<td>2 arteries</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>3 arteries</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>4 arteries</td>
<td>04</td>
<td>08</td>
</tr>
<tr>
<td>5 arteries</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>1 vein</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>2 veins</td>
<td>36</td>
<td>72</td>
</tr>
<tr>
<td>4 veins</td>
<td>01</td>
<td>02</td>
</tr>
<tr>
<td>1 duct</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>
Hepatic artery proper is a branch of the common hepatic artery, it passes through the right free margin of the lesser omentum and enters the PH where it divides into right and left branch. Number of arteries found in PH in the present study was from one to five; two arteries were seen in 56% of specimen and three arteries in 26%. Five arteries were seen in 2% of the liver (Fig. 4). Common variations reported about the hepatic artery is about its branching pattern and its accessory arteries.10–12 A study has also reported about the anomalous variation of the origin of the right and left hepatic artery.13

A surgeon should have immense knowledge about the variants of the hepatic artery to reduce iatrogenic complications in hepatobiliary surgeries, surgical management of liver trauma, aneurysm of hepatic artery, hepatic arterial infusion chemotherapy, liver transplant surgery, and other such surgeries of this complex anatomic region.14

In the present study, single hepatic duct was observed in all the livers, and hepatic duct showed no branching (Figs. 2–6). As mentioned in Gray’s text book of anatomy, the main right and left hepatic ducts unite near the right end of PH as the common hepatic duct and passes downwards within the right free margin of the lesser omentum.15 However, in our study, we have not observed the right and left extrahepatic part of the hepatic duct. Our finding correlates with similar observations, single duct was observed in 79.7 and 76% of liver specimens, respectively.14 Anatomical and radiological studies have shown the presence of accessory hepatic ducts at different levels of the biliary tree and also observed the absence of right and left hepatic ducts.16–19 Because of these anatomic variations, it becomes very much important to have knowledge about these hepatic duct variations of accessory hepatic ducts and also about their position, especially during laparoscopic cholecystectomies, as incidence of bile duct injuries is as twice as high when compared with open cholecystectomies.20

Biliary anatomy and its common and uncommon variations are of considerable clinical significance when performing living donor transplantsations, radiological interventions in hepatobiliary system, laparoscopic cholecystectomy, and liver resection (hepatectomy, segmentectomy). Magnetic resonance cholangiopancreatography has become the modality of choice for noninvasive evaluation of abnormalities of the biliary tract.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Comparison of observations of the present study with figures quoted in similar studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>Present study</td>
</tr>
<tr>
<td>Number of specimens</td>
<td>50</td>
</tr>
<tr>
<td>Transverse diameter of the porta hepatis</td>
<td>2.4–4.5 cm</td>
</tr>
<tr>
<td>Anteroposterior diameter of porta hepatis</td>
<td>1.0–2.6 cm</td>
</tr>
<tr>
<td>Total circumference</td>
<td>7.5–12.8 cm</td>
</tr>
<tr>
<td>Most common combination</td>
<td>2A 2V 1D (36%)</td>
</tr>
<tr>
<td>Max no. of arteries</td>
<td>05</td>
</tr>
<tr>
<td>Max no. of veins</td>
<td>04</td>
</tr>
<tr>
<td>Max no. of ducts</td>
<td>01</td>
</tr>
</tbody>
</table>

Abbreviations: A, artery; D, duct; V, vein.

Conclusion

The findings in this study will help anatomists, radiologists, and surgeons to understand the variations of dimensions, number, and arrangement of structures at PH.

Conflict of Interest

None.

References

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