Morphological Variations and Measurements of the Caudate Lobe of the Human Liver: A Cadaveric Study

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Abstract

Background: The caudate lobe is an anatomic segment of the human liver and has a great clinical importance in hepatic diseases.

Aim of Study: The aim of this study was to evaluate the morphological variations and anatomical measurements of the caudate lobe of the human liver that could be important in interpretation of its pathological conditions.

Material and Methods: Measurements and morphological analysis of the caudate lobe of the human liver were determined in 56 formalin fixed human liver specimens in the Anatomy and Embryology Department, Faculty of Medicine, Zagazig University, Egypt.

Results: The common shape of the caudate lobe was rectangular. The mean length of the caudate lobe was 57.45 ± 4.74mm while the mean of its transverse diameter was 27.49 ± 2.82mm. The mean of transverse diameter of the right lobe of the liver was 90.58 ± 7.76mm and also, the mean of caudate lobe-right lobe (CL/RL) ratio was 0.30 ± 0.03.

Conclusion: Variable shapes of the caudate lobe of the liver were present. The ratio of the transverse diameter of caudate lobe to that of the right lobe of the liver ranged between 0.22-0.38. The collected data in this study may be valuable to aid the surgeons in proper planning of hepatic surgery and to avoid the misdiagnosis of hepatic diseases.

Key Words: Liver – Caudate – Accessory fissures – Variations.

Introduction

The human liver is located in the right hypochondrium, epigastrium and extends into the left hypochondrium and has five surfaces (anterior, superior, right, inferior and posterior surfaces) [1]. The liver is divided by ligamentum venosum, ligamentum teres and falciform ligament into right, left, quadrate and caudate lobes, also the liver is formed of eight functional segments [2]. Chavan and Wabale [3] stated that anatomically, the caudate lobe belongs to the right lobe of the liver but physiologically it belongs to the left lobe. Patil et al., [4] added that the liver is variable in size according to the age, sex and human body size. The caudate lobe is an anatomic distinct segment of the liver, located on its posterior surface and bounded by inferior vena cava on its right side and groove for ligamentum venosum on its left side [3,5]. Inferiorly, the caudate lobe of the liver shows a lateral caudate process that extends obliquely to the right lobe of the liver and a medial small projection called papillary process [6]. Lobectomy of caudate lobe of the liver is the most appropriate treatment for its localised benign tumors [7]. The caudate lobe shows some morphological variations and only few studies discussed these surface variations [3,4,8]. Although, there is advancement in the imaging techniques as the magnetic resonance imaging in evaluation of the human liver, studies of the anatomical features of the cadaveric liver are still highly valuable in recording its anatomical variations [9,10]. In some cases, the papillary process of caudate lobe was large and during imaging it can simulate mass in the head of pancreas or periportal lymph nodes [11]. The aim of the present work was to study the morphological variations and anatomical measurements of the caudate lobe of the human liver to aid radiologists and surgeons for proper planning of hepatic surgery. Also, the ratio of the transverse diameter of the caudate lobe to that of the right lobe of the liver (CL/RL ratio) was determined that is important in diagnosis of the liver cirrhosis.

Material and Methods

The study was implemented on 56 human liver specimens (formalin fixed) available in the dissection room and museum of the Anatomy and Embryology Department, Faculty of Medicine, Zagazig University, Egypt. This study was approved by Institutional Review Board, Faculty of Medicine,
Inclusion criteria: All cadaveric liver specimens included in this study had normal anatomical features and the weight of each liver was ranged from 1.2-1.8kg.

Exclusion criteria: The cadaveric liver specimens had features of damage, hepatic surgery or tumours were excluded from this study.

The caudate lobe was studied for its size, shape, variations in the papillary and caudate processes and the presence of fissures. To determine the transverse diameter of caudate lobe, the midpoint of hepatic part of inferior vena cava (I.V.C.) was used as a reference point for the right lateral margin of the caudate lobe [3] as in Fig. (1). The transverse diameter of the remaining part of right lobe of the liver was recorded by using the same reference point [3] as in Fig. (2) and the ratio of transverse diameter of caudate lobe to that of the right lobe (CL/RL ratio) of the liver was determined. The inferior level of hepatic part of I.V.C. (or its groove) was determined at the posterior border of caudate process of the caudate lobe of the liver [12,13]. The length of the caudate lobe was measured from its lower border above the porta hepatis and portal vein [14] as in Fig. (3). The previous measurements were recorded in mm by electronic digital caliber (three readings were noted for each parameter then the maximum reading was recorded).

Statistical analysis: SPSS (Version 22, IBM Corp. Armonk, New York, USA) program was used for calculating the data of caudate lobe of the human liver included the percentage of its different shapes, presence of accessory fissures and variations of caudate and papillary processes. Measurements of caudate lobe and transverse diameter of right lobe of the liver were expressed in the form of mean±standard deviation (SD), minimum and maximum for each parameter.

Results

In this research, the caudate lobe showed various shapes. The caudate lobe was rectangular in 41 liver specimens (73.21%), triangular in 12 specimens (21.43%) and irregular in 3 specimens (5.36%) (Figs. 4,5,6 respectively and Graph 1).

The length of the caudate lobe ranged between 46.85-69.63mm (its mean length was 57.45±4.74mm) and its transverse diameter ranged between 22.16-37.16mm (its mean transverse diameter was 27.49±2.82mm). The transverse diameter of the right lobe of the liver ranged between 73.51-115.12mm and its mean diameter was 90.58±7.76mm. The ratio between transverse diameter of the caudate lobe and that of the right lobe of the liver ranged between 0.22-0.38 and its mean was 0.30±0.03. In 15 liver specimens (26.79% of total number of liver specimens), there was a longitudinal fissure that extended upwards from the lower border of caudate lobe (Figs. 7,8). In 8 liver specimens (14.29% of total number of liver specimens) accessory fissures were present between the caudate process of the liver and the duodenal impression (Figs. 4,8). Out of these 8 specimens, two specimens were associated also with fissure for liga-
mentum teres on the anterior surface of the liver (Figs. 9A-9B). Also, out of these 8 specimens, in 3 liver specimens there was association between the longitudinal fissure in the caudate lobe with accessory fissure present between the caudate process of the liver and the duodenal impression (Fig. 8). In the present study, the papillary process was prominent and seen in 24 liver specimens (42.86% of total number of liver specimens) (Figs. 4, 7) and out of these 24 liver specimens, only three liver specimens showed a large papillary process (Figs. 10, 11). Also, in all liver specimens the caudate process was seen as shown in Figs. 4, 7, 8.

Fig. (4): A photograph showing rectangular shaped caudate lobe (CL) of the human liver. Accessory fissure (curved arrow) is seen between caudate process (CP) of the caudate lobe and duodenal impression (arrow). The papillary process (PP) is present and also the gall bladder (G.B.) is present in its fossa on the inferior surface of right lobe of the liver.

Fig. (5): A photograph showing triangular shaped caudate lobe (CL) of the human liver.

Fig. (6): A photograph showing irregular shaped caudate lobe (CL) of the human liver.

Fig. (7): A photograph showing a longitudinal fissure (arrow) extending upwards from the lower border of caudate lobe (CL). Papillary process (PP) and caudate process (CP) were prominent.

Fig. (8): A photograph showing a longitudinal fissure (arrow head) extending upwards from the lower border of the caudate lobe of the liver (CL) and is associated with accessory fissure (curved arrow) that is present between the caudate process (CP) of the liver and the duodenal impression (arrow).

Fig. (9) (A&B): Photographs showing fissure (arrow) for ligamentum teres (curved arrow) on the anterior surface of the liver.
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![Image of liver with labels: PP, CL, CP](image1)

**Fig. (10):** A photograph showing large papillary process (PP) of the caudate lobe (CL) directed toward the porta hepatis. The caudate process (CP) is present.

![Image of liver with labels: PP, CL](image2)

**Fig. (11):** A photograph showing large papillary process (PP) of the caudate lobe (CL) directed toward the left lobe of the liver.

![Bar chart showing frequency of different shapes of the caudate lobes](chart)

**Graph (1):** A bar chart showing frequency of different shapes of the caudate lobes of the studied human livers.

![Graph showing frequency of different shapes of the caudate lobes](chart2)

**Fig. (10):** A photograph showing large papillary process (PP) of the caudate lobe (CL) directed toward the porta hepatis. The caudate process (CP) is present.

**Fig. (11):** A photograph showing large papillary process (PP) of the caudate lobe (CL) directed toward the left lobe of the liver.

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**Table (1):** Showing the various shapes of the caudate lobe of the liver specimens in different studies.

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<tr>
<td>Rectangular</td>
<td>94.5%</td>
<td>58%</td>
<td>48%</td>
<td>48%</td>
<td>91.66%</td>
<td>73.21%</td>
</tr>
<tr>
<td>Triangular</td>
<td>8%</td>
<td>20%</td>
<td>4%</td>
<td>12%</td>
<td>5.55%</td>
<td>21.43%</td>
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<tr>
<td>Irregular</td>
<td>1%</td>
<td>4%</td>
<td>12%</td>
<td>16%</td>
<td>5.36%</td>
<td>2.77%</td>
</tr>
<tr>
<td>Elongated</td>
<td>–</td>
<td>8%</td>
<td>26%</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pear</td>
<td>4.5%</td>
<td>10%</td>
<td>18%</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Others</td>
<td>–</td>
<td>4%</td>
<td>6%</td>
<td>–</td>
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**Discussion**

During the third week of foetal life, the liver starts its organogenesis [15]. Although the liver has a complex development but its gross abnormalities are very rare [16]. The caudate lobe has clinical importance due to its separate biliary drainage and blood supply, so it has paradoxical behaviour in comparison with the remaining parts of the liver as in liver cirrhosis [14]. In the present study the midpoint of hepatic part of IVC used as a reference point for determination of the right margin of the caudate lobe of the liver and measurement of transverse diameters of both caudate lobe and the remaining part of right lobe of the liver then determination of CL/RL ratio. The midpoint of hepatic part of IVC is an ideal reference point as it remains unchanged even in the presence of narrowing or widening of IVC [3]. In a study by Giorgio et al., [17] used the lateral right margin of the main portal vein at its bifurcation as a reference point for determination of the right margin of caudate lobe of the liver while Chavan and Wabale [3] revealed that the maximum transverse diameter of different shapes of the caudate lobe was present at a level higher than the main portal vein. Also, in cases of liver cirrhosis dilatation of portal vein due to portal hypertension may occur, so assessment of the maximum transverse diameter of caudate lobe by using the lateral right margin of the main portal vein as a reference point may give a false reading [3]. In a study conducted on 54 livers, there was absence of caudate lobe of the liver in 7.41% of the liver specimens [18]. In the present study, there were variations in the shapes of the caudate lobes of the livers and the percentages of these variations were compared with relevant studies as shown in Table (1).
The differences in the percentages of the variations of the shapes of the caudate lobes of the livers may be due to the differences in the number of the liver specimens under each study [8]. In the present work, the length of the caudate lobe ranged between 46.85-69.63mm while its transverse diameter ranged between 22.16-37.16mm. Also, the transverse diameter of the remaining part of the right lobe of the liver ranged between 73.51-115.12mm and the ratio between transverse diameter of the caudate lobe and that of the right lobe of the liver (CL/RL ratio) ranged between 0.22-0.38. When the liver shrinks as in the liver cirrhosis, compensatory hypertrophy of the caudate lobe of the liver occurs [19]. In cases of liver cirrhosis, the ratio of the transverse diameter of caudate lobe to that of the right lobe of liver becomes equal or more than 0.65 [3]. The measurements of the parameters of the caudate lobe of the liver in the present study were compared with the results of Sahni et al., [8], Chavan and Wabale [3], and Arora et al., [14] as shown in Table (2).

Table (2): Showing the comparison of the various measurements of the caudate lobe of the liver specimens in different studies.

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<tbody>
<tr>
<td>Length of caudate lobe</td>
<td>40-72mm</td>
<td>40-93mm</td>
<td>33.8-70.3mm</td>
<td>46.85-69.63mm</td>
</tr>
<tr>
<td>Transverse diameter of caudate lobe</td>
<td>18-41mm</td>
<td>25-42mm</td>
<td>12-42.4mm</td>
<td>22.16-37.16mm</td>
</tr>
<tr>
<td>Transverse diameter of right lobe of liver</td>
<td>–</td>
<td>67-105mm</td>
<td>52.9-99.3mm</td>
<td>73.51-115.12mm</td>
</tr>
<tr>
<td>Ratio of transverse diameter of caudate lobe to that of the right lobe of the liver (CL/RL ratio)</td>
<td>0.23-0.40</td>
<td>0.28-0.46</td>
<td>0.15-0.58</td>
<td>0.22-0.38</td>
</tr>
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In conclusion, variable shapes of the caudate lobe of the liver specimens were present in this work and the most common shape was rectangular. The determination of the ratio of the transverse diameter of caudate lobe to that of the right lobe of the liver (CL/RL) is important to diagnose the liver cirrhosis and in this study the mean of (CL/RL) ratio was 0.30±0.03. Identification of accessory fissures of the caudate lobe is very important to avoid false diagnosis of the cystic lesions of the liver. These data may be valuable for radiologists and surgeons to assist in proper planning of hepatic surgery.

References


