



ANATOMICAL STUDY OF CAUDATE LOBE OF LIVER AND ITS CLINICO-EMBRYOLOGICAL IMPLICATIONS

Anatomy

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ABSTRACT

Summary Introduction: The caudate lobe is one of four anatomical lobes of the liver. It has portal blood supply and hepatic vein drainage independent of the remainder of the liver and may be differentially affected in liver pathologies. **Material And Method:** The study was carried out on 30 adult cadaveric livers available in the Department of Anatomy, VMMC and Safdarjung Hospital in which morphology, morphometry and variations were noted. **Result:** The caudate lobe showed a wide range of variations. Caudate lobe was present in all 30 specimens of liver out of which, 16 specimens showed rectangular shape (53.33%), 3 triangular (10%), 3 elongated (10%), 2 oval (6.6%), 2 inverted flask (6.6%), 1 pear (3.3%), 1 irregular (3.3%). **Clinical Implications:** The variations of the caudate lobe should be kept in mind in order to achieve correct preoperative diagnosis, thus it will be helpful for the surgeon in planning for surgeries on caudate lobe of liver. **Conclusion:** The present study strives to elucidate a detailed morphological account of the caudate lobe of liver. These findings are of immense value for both pre-operative evaluation and post-operative care of the patient.

KEYWORDS

liver, caudate lobe, morphometry, papillary process, caudate process

INTRODUCTION

The liver is the largest of all abdominal viscera and it has been considered to be divided into right, left, caudate and quadrate lobes by the peritoneal attachments. [1] The caudate lobe is one of four anatomical lobes of the liver. The caudate lobe is bounded on the left by the fissure for the ligamentum venosum, inferiorly by the porta hepatis, on the right by the groove for the inferior vena cava, superiorly it continues into the superior surface of the right upper end of the fissure for the ligamentum venosum. [2] The caudate lobe is subdivided into Spiegel's lobe (the caudate lobe proper and the papillary process), the caudate process and the paracaval portion, which is anterior to the inferior vena cava. [15] It is connected to the right lobe of the liver by the caudate process, which passes laterally between the portal vein and the inferior vena cava at the porta hepatis. It has portal blood supply and hepatic vein drainage independent of the remainder of the liver and may be differentially affected in liver pathologies. Dodds et al., hypothesized that during second trimester the ductus venosus rotates rightward as the liver enlarges, so that a small portion of the liver become inserted behind the mesentery for the ductus venosus, which gives rise to caudate lobe of liver. [2] Using the ratio of transverse caudate lobe width to transverse right lobe width—the Harbin Index—cirrhotic livers could be separated from non-cirrhotic livers (both healthy and those with other hepatic pathologies) with a sensitivity of 84 % and a specificity of 100 % [3, 4]. The aim of this study was to study morphology, morphometry and variations of caudate lobe to aid radiologists and surgeons for better interpretation and intervention. Knowledge and awareness of these variations are useful for clinicians for the diagnosis and management of hepatic disorders and surgeons during segmental resection of liver and radiologist for avoiding misinterpretation of CT and MRI.

MATERIALS AND METHODS

The study was carried out on 30 adult cadaveric livers available in the Department of Anatomy, VMMC and Safdarjung Hospital. Livers were removed en bloc from the cadavers along with intra-hepatic part of inferior vena cava and structures in the lesser omentum. Any livers from cadavers with previous history or appearance of cirrhosis, metastatic disease or other liver pathology and any cadavers with previous history of or an appearance suggestive of abdominal surgery, trauma or disease were excluded from the study. Anatomy of the caudate lobe was studied after defining and cleaning lesser omentum covering its two of the four margins. Inferior vena cava and ligamentum venosum determine its transverse extent and porta hepatis with portal vein determine its vertical extent. Hence, mid-point of inferior vena cava was taken as reference point in determining the width of caudate lobe and portal vein to determine length of the lobe. The shape of caudate lobe, presence of papillary and caudate process, vertical fissure extending upwards from the lower border of the caudate lobe was noted. The following measurements of caudate lobe and right lobe of liver were taken using vernier calipers [Figure 1].

1. The maximum transverse diameter of caudate lobe was measured.
2. The maximum vertical length of the caudate lobe was measured.
3. The transverse diameter of right lobe of liver was taken from right margin of the portal vein in the porta hepatis.
4. The maximum vertical length of right lobe of liver was measured.

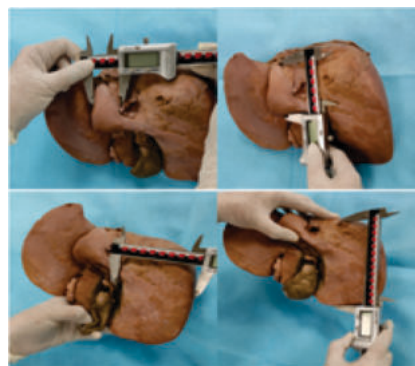


Figure 1: Morphometric measurements of caudate lobe of liver

RESULTS

The caudate lobe showed a wide range of variations. Caudate lobe was present in all 30 specimens of liver out of which, 16 specimens showed rectangular shape (53.33%), 3 triangular (10%), 3 elongated (10%), 2 oval (6.6%), 2 inverted flask (6.6%), 1 pear (3.3%), 1 irregular (3.3%) (Figure 2). In 1 specimen, papillary process was present, vertical fissure extending upwards from the inferior border of the caudate lobe was seen in 3 specimens (10%) and caudate process was present in 20 specimens (66.6%). The vertical length of the caudate lobe ranged between 3.5-7.4 cm (Average 5.4 cm) and maximum transverse diameter ranged between 1.8-3.8 cm (Average 2.96 cm). The vertical length of the right lobe ranged between 8-16 cm (Average 13.5 cm) and transverse diameter was measured from the right lateral wall of the main portal vein ranged between 6.5 -10.2 cm (Average 8.3 cm). The ratio of the length of caudate lobe to right lobe is 0.4 and the ratio of transverse diameter of caudate lobe to right lobe 0.35.

Table 1: Morphometric data of caudate lobe of liver

	RANGE	AVERAGE
LENGTH OF CAUDATE LOBE	3.5-7.4cm	5.4cm
TRANSVERSE DIAMETER OF CAUDATE LOBE	1.8-3.8 cm	2.96cm
LENGTH OF RIGHT LOBE	8-16cm	13.5cm

TRANSVERSE DIAMETER OF RIGHT LOBE	6.5-10.2cm	8.3cm
RATIO OF LENGTH		0.4
RATIO OF TRANSVERSE DIAMETER		0.35
	NO. OF SPECIMENS	PERCENTAGE
Shape	Rectangular 16	53.33
	Elongated 3	10
	Pear 1	3.3
	Triangular 3	10
	Inverted flask 2	6.6
	Oval 2	6.6
	Irregular 1	3.3
Vertical fissure	3	10
Papillary process	1	3.3
Caudate process	20	66.6



Figure 2: Different shapes of caudate lobe of liver



Figure 3: Papillary process



Figure 4: Caudate process



Figure 5: Vertical Fissure

DISCUSSION

Table 2: Comparision Of Morphological Data With Different Authors

SHAPE	Present study	Arora NK et al[5]	Sahani et al[6]	Joshi et al[7]	Chavan et al[8]	Nayak et al[9]
RECTANGULAR	53.33%	91.66%	94.5%	58%	48%	-
TRIANGULAR	3%	5.55%	-	22%	4%	-
ELONGATED	3%	2.77%	-	-	-	-
PEAR	1%	-	4.5%	-	26%	-
INVERTED FLASK	2%	-	-	-	2%	-
SQUARE	-	-	-	-	6%	-
BICORNUATE	-	-	-	20%	-	-
IRREGULAR	1%	-	1%	-	-	-
OVAL	2%	-	-	-	14%	-
DUMBELL	-	-	-	-	-	1.81%

In the present study, caudate lobe was present in all the 30 specimens and various shapes of the caudate lobe were observed. 16 specimens were rectangular in shape (53.33%), 3 were elongated (3%), 3 were triangular (3%), 2 were inverted flask shaped (2%), 2 were oval shaped (2%), 1 was pear shaped (1%) and 1 was irregular in shape (1%). Arora et al [5] studied caudate lobe in 36 specimens out of which, 33 specimens showed rectangular shape (91.66%), 2 triangular (5.55%), and 1 columnar (2.77%). In 5 specimens, papillary process was present. Vertical fissure extending upwards from the inferior border of the caudate lobe was seen in 7 specimens (19.44%). In all the specimens, caudate process was present whereas caudate isthmus and accessory caudate lobe were absent. Sahni et al[6] studied 200 specimens and observed that 189 (94.5%) were rectangular in shape, 9(4.5%) were pyriform and 2 (1%) were irregular. They also observed the presence of papillary process in 67 (33.5%) specimens on the inferior surface near the left anterior angle. Joshi et al[7] studied 90 specimens out of which 58% rectangular, 20% bicornuate, and rest 22% (20 specimens had different shapes, i.e. pear-shaped, quadrate, triangular, elongated, heart-shaped, square and inverted pear-shaped). They observed the presence of caudate isthmus. The caudate lobe was noticed to be made up of two portions, connected by a narrow parenchymal bridge, which is known as the caudate isthmus. One part was situated to the left of the inferior vena cava, corresponding to the Spiegel's lobe or Couinaud's segment I. The other part extended in front of and to the right of the inferior vena cava. This part also extended caudally as a caudate process. This is termed as the paracaval portion. Chavan et al [8] reported that 24 specimens had a rectangular shape (48%), 13 pear shaped (26%), 7 oval (14%), 3 (6%) square, 2 (4%) triangular and 1 (2%) inverted flask shaped and there was the absence of papillary process in all 50 cases of their study. Nayak[9] reported an abnormal, dumb-bell like caudate lobe in one liver (1.81%) and the papillary process of the caudate lobe was very large in one liver (1.81%). In this present study, the presence of papillary process was seen in 1 specimen.

From the right anterior angle of the caudate lobe, the caudate process extends anteriorly and to the right where hepatic tissue of the caudate lobe merges with the right lobe of liver. Depending upon the position of the fissure on its left at its commencement, its base could be broad or narrow. In the present study, the caudate process was present between the porta hepatis anteriorly and the fossa for the inferior vena cava posteriorly. Sahni et al[6] found that the caudate process was present in 119 (59.5%) specimens.

The present study shows presence of caudate process in 20(66.6%) specimens. Vertical fissure extending upwards from the inferior border of the caudate lobe was seen in 3 specimens (10%) whereas Joshi et al[7] reported an incidence of 30%. Sahni et al[6] reported that fissures of variable length and positions were present on various borders of the caudate lobe in 104 specimens. Chavan and Wabale[7] reported that the ratio of transverse dimension of caudate lobe to right lobe ranged between 0.28-0.46 which was slightly higher than Sahni et al[5] i.e. 0.23-0.40. In the present study, the ratio of transverse diameter was found to be 0.35. Chavan and Wabale[7] reported that the caudate lobe undergoes compensatory hypertrophy when rest of the liver shrinks, as reported by many studies[11]. This fact has been used to diagnose

conditions such as cirrhosis of liver (CL/RL ≥ 0.65) [11]. In the present study, the ratio of caudate lobe length to the right lobe length was 0.4.

Embryology:

Development of the caudate lobe is shrouded in mystery; it has been said to develop from either the left or right hepatic lobe. The origin of the blood supply to the caudate lobe is uncertain. To address this problem, we propose a unifying hypothesis about developmental caudate embryology that we think clarifies existing anatomic findings in the adult. We propose that the key to understanding the development of the caudate lobe is the ductus venosus, which in early embryonic life is suspended within the superior portion of the dorsal mesentery of the liver. In the early embryo, the primitive gastrointestinal tract, including the esophagus, is suspended along its length by both a dorsal and ventral mesentery [12, 13]. Most of the ventral mesentery disappears, but the liver develops in the ventral mesentery, resulting in a dorsal portion of lesser omentum with persistence of the gastrohepatic and hepatoduodenal ligaments. All vascular structures to the liver that connect to posterior structures, such as the aorta or the vena cava, must run through the dorsal mesentery of the liver and dorsal mesentery of the duodenum to reach the liver. For example, the gastrohepatic artery originates from the aorta, but through a series of mesenteric twists and foldings, its original mesentery is no longer apparent in the adult. Yet the course of this artery and its major branches provides clear evidence of the original location of their mesentery [14]. In similar fashion, we propose that the ductus venosus originally was suspended by a dorsal mesentery early in embryologic development (Fig. 7), and part of this mesentery later disappeared. The history of this mesentery delineates the development of the caudate lobe. At present, there is little argument that a ligament (within the original mesentery) persists from the original ductus venosus in the adult liver [5]. In adults, the ligament of the ductus venosus passes through the liver from the base of the left portal vein to the vena cava to which it is attached [12,13]. The ligamentum venosum passes between the leaves of the original dorsal mesentery of the liver [12]. The mesentery persists as the fissure for the ligamentum venosum.

Clinical Implications:

The incidence of morphological shape variations of caudate lobe is very high in this study. These variations should be kept in mind in order to achieve correct preoperative diagnosis, thus it will be helpful for the surgeon in planning for surgeries on caudate lobe of liver. The papillary process of caudate lobe is a potential source of pitfalls in interpretation of CT images at and just below the porta hepatis. These errors can be avoided if the CT images are analysed carefully with reference to the gross anatomy of caudate lobe. Caudate lobe/Right lobe ratio is important for diagnosing conditions of the liver such as cirrhosis on Ultrasound/ Computed topography /Magnetic resonance imaging. Knowledge and awareness of these variations are useful for Clinicians for the diagnosis and management of hepatic disorders, Surgeons during segmental resection of liver and Radiologist for avoiding misinterpretation of CT and MRI.

CONCLUSION

The present study strives to elucidate a detailed morphological account of the caudate lobe of liver. These findings are of immense value for both pre-operative evaluation and post-operative care of the patient.

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