

Morphological Variations and Morphometric Analysis of the Caudate Lobe of Liver: A Cadaveric Study

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ABSTRACT

Introduction: The caudate lobe is most referred area of the liver radiologically. In cirrhosis, the right lobe exhibits relatively greater shrinkage, while the caudate lobe undergoes relative enlargement as it is the only segment which receives blood independently from left and right branches of portal veins. **Aims:** To assess the morphological variations and morphometric analysis of the caudate lobe of liver in the cadavers. **Methods:** This was a cross-sectional descriptive study conducted on 48 formalin fixed human liver specimens available in the gross anatomy laboratory of Department of Anatomy, National Medical College, Birgunj, Nepal. The caudate lobe of liver specimens was studied for morphological variations and different measurements were taken, and the result was presented in tables. **Results:** The caudate lobe showed a wide range of variations in shape. Caudate lobe was present in all 48 specimens of liver out of which, 15 specimens were rectangular (31.25%), 26 specimens were pyriform (54.16%) and 7 specimens were irregular (14.58%) respectively. In 6 liver specimens (12.50% of total number of liver specimens), there was vertical fissure that extended upwards from the lower border of caudate lobe was seen in 6 specimens (12.50%). Notch was present in 10 specimens (20.83%). **Conclusion:** The caudate lobe of the liver showed a great degree of variations and the most common shape was pyriform. The ratio of the transverse diameter of the caudate lobe to that of the right lobe of the liver (CT/RL) ratio was found to be 0.14.

Keywords: Caudate lobe, Variations, Cirrhosis, Harbin index

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INTRODUCTION

The human liver, the largest gland and second largest organs of human body is divided into 4 lobes (right, left, quadrate, and caudate), as well as into eight functional segments, by different ligaments.^{1,2} The caudate lobe (also known as the Spigelian lobe or Couinauds segment-I) is an anatomically distinct segment of the liver that is bounded on the left by the fissure for ligamentum venosum, on the right by the groove for the inferior vena cava, inferiorly by the porta hepatis, and superiorly by the superior surface of the right upper end of the ligamentum venosum.³ It is separated into three sections: the caudate lobe proper, the papillary process, and the paracaval part.⁴ It has a medial small projection called papillary process and a lateral caudate process that extends obliquely to the right lobe of the liver.⁵ In Couinaud's classification, the caudate lobe is segment-I, and it is the only segment that receives blood from both the left and right branches of

portal veins.^{6,7} The caudate lobe, on the other hand, drains through several minor hepatic veins that open into the inferior vena cava separately from the major hepatic veins.⁸ It is thus physically and functionally distinct.⁹ Cirrhotic and non-cirrhotic livers could be distinguished using the Harbin Index (ratio of transverse diameter of caudate lobe and right lobe).^{10,11} The main objective of this cadaveric study is to observe the morphological variations and morphometric analysis of caudate lobe of liver.

METHODS

This is a cross-sectional descriptive study. The investigation was conducted on 48 human liver specimens (preserved in formalin) accessible in the dissecting room and museum of the Department of Anatomy, National Medical College, Birgunj, Nepal, for a period of six months.

Inclusion and exclusion criteria: All the livers with normal

anatomical features available in the department of anatomy were selected and human cadaveric liver specimens which were damaged during dissection, having cirrhotic changes, tumors, performing hepatic surgery and obvious hepatomegaly were excluded from this study.

Morphology of the caudate lobe of liver: The gross anatomy of caudate lobe was studied for its shape, presence or absence of fissure, or notch and presence or absence of papillary and caudate processes and their variations. On the basis of its shape as described in various literature we have grouped all the liver specimens into three categories: rectangular, piriform and irregular.¹¹

Piriform	Rectangular	Irregular
Caudate lobe wider at either superior or inferior extent, narrow at the opposite extent	Caudate lobe roughly equal in size at both superior and inferior extents, overall presents a rectangular shape	Caudate lobe has irregular boundaries and does not fit either piriform or rectangular classifications

Table 1: Classification of caudate lobe of liver on the basis of its shape

Morphometry: The maximum transverse dimension of the caudate lobe (CT) [Figure 1] and right lobe (RL) [Figure 3] and the vertical extent (length) of both caudate lobe [Figure 2] and right lobe [Figure 4] were measured using vernier caliper. The Harbins Index (CT\RL) is then calculated by dividing the maximum transverse diameter of caudate lobe by maximum transverse diameter of right lobe.

The transverse diameter of caudate lobe is the distance from the most medial margin of caudate lobe to the right lateral wall of the portal vein, and transverse diameter of right lobe extends from the right lateral wall of the portal vein to the most lateral margin of the right lobe. Similarly, the length of caudate lobe and right lobes were measured at the level of greatest longitudinal extension of the caudate lobe. The caliper is manufactured by Syber Hegne and Company AG. Wiesentrausses 8, 8008 Zurich, Switserland. All the measurements of caudate lobe and right lobe of liver were taken three times, and the mean readings of each parameter were recorded in performa as final readings.

Data management and analysis: All the measurements and morphological features are first collected in the performa and entered in Excel 2007 and the mean, standard deviation and percentage were calculated. Measurements of transverse diameter of the caudate lobe and the right lobe of the liver were expressed in the form of mean standard deviation (SD) in table and compare it with the other similar study.



Figure 1: Measurement of transverse diameter of caudate lobe



Figure 2: Measurement of the vertical length of the caudate lobe



Figure 3: Measurement of transverse diameter of the right lobe of liver



Figure 4: Measurement of vertical length of the right lobe of liver

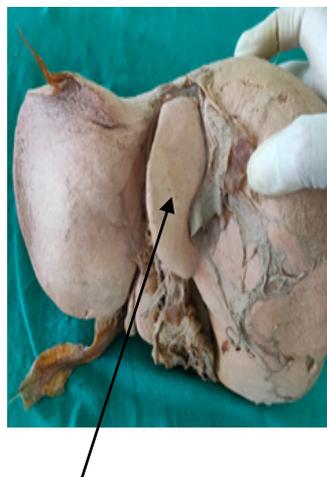


Figure 5: Piriform



Figure 6: Rectangular



Figure 7: Irregular



Figure 8: Fissure

Measurement	Range (mm)	Mean± SD
Transverse diameter of caudate lobe	19.24-43.01	30.05±4.93
Vertical length of caudate lobe	49.61-70.22	57.46±5.26
Transverse diameter of right lobe	61.05-111.25	90.87±12.52
Vertical length of right lobe	109.27-149.12	127.31±11.57
Area of caudate lobe (in mm ²)	1003.65-2394.83	1728.62±328.37
Area of right lobe (in mm ²)	7387.05-11532.34	11610.41±2119.83
Ratio of caudate lobe to right lobe	0.074-0.244	0.14

Table III: Various measurements of cadaveric livers

RESULT

The shape of the caudate lobe varied dramatically. All 48 liver specimens had a caudate lobe, with 15 being rectangular (31.25%), 26 being pyriform (54.16%), and 7 being irregular (14.58%). (Figures 5, 6, 7). A vertical fissure extending upwards from the bottom border of the caudate lobe was found in 6 liver specimens (12.50 % of the total number of liver specimens) (Figure 8). In 10 specimens (20.83%), Notch was present.

Morphological features	Frequency (N)	Percentage (%)
Shape		
Pyriform	26	54.16
Rectangular	15	31.25
Irregular	7	14.58
Notch	10	20.83
Vertical Fissure	6	12.50

Table II: Frequency of distribution of cadaveric Liver

Table III represents various ranges of different diameters and their Mean ±SD of cadaveric livers. The caudate lobes transverse diameter (Figure 1) ranged from 19.24 to 43.01 mm, with a mean length of 30.05 mm. The caudate lobe's vertical length (Figure 2) ranged from 49.61 to 70.22 mm, with a mean of 57.46 mm. The right lobes transverse diameter (Figure 3) measured from the right lateral wall of the major portal vein ranged from 61.05 to 111.25 mm, with a mean length of 90.87 mm. The right lobes vertical length (Figure 4) ranged from 109.27 to 149.12 mm, with a mean of 127.31 mm. The caudate lobe area ranged from 1003.65-2394.83 sq. mm, with a mean of 1728.62sq.mm. The right lobe area ranged from 7387.05 to 11532.34sq.mm, with a mean of 11610.41mm. The caudate lobe to right lobe ratio ranged from 0.074 to 0.244mm. The transverse diameter of the caudate lobe to the right lobe was 0.14 on average.

Shape	Sahni et al ¹¹ (200)	Joshi et al ⁵ (90)	Chavan et al ¹⁴ (50)	Nayak et al ¹⁶ (55)	Present study (48)
Rectangular	94.5%	58%	48%	-	31.25%
Triangular	-	-	4%	-	-
Elongated	-	-	-	-	-
Pyriform	4.5%	-	26%	-	54.16%
Inverted flask	-	22%	2%	-	-
Heart Shape	-	-	-	-	-
Square	-	-	6%	-	-
Bicornuate	-	20%	-	-	-
Irregular	1%	-	-	-	14.58%
Oval	-	-	14%	-	-
Dumb-bell	-	-	-	1.81%	-

Table IV: Comparison of measurements among previous and present study

DISCUSSION

The liver starts its organogenesis during the third week of foetal phase. During its development it passes through a complex embryological process yet its gross defects are quite infrequent. The caudate lobe has clinical importance due to its independent biliary drainage and blood supply; hence it shows paradoxical behaviour in comparison with the rest regions of the liver like in liver cirrhosis.

Present investigation demonstrates the caudate lobe was discovered in all the 48 specimens, which is compatible with the work of Joshi et al.⁵ However, according to Aktan et al¹² in 54 livers, there was absence of caudate lobe in 7.41 %. Various morphologies of the caudate lobe were discovered in which 15 specimens were rectangular (31.25 %), 26 specimens were pyriform (54.16%) and 7 specimens were irregular (14.58 %) in shape, respectively. Out of 90 specimens tested by Joshi

et al⁵, 58% were rectangular, 20% bicornuate, and remainder 22% (20 specimens had varied shapes, i.e., pear shaped, quadrate, triangular, elongated, heart-shaped, square and inverted pear shaped) as shown in table IV. Sahni et al¹¹ investigated 200 specimens and observed that 189(94.5%) were rectangular, 9(4.5%) pyriform and 2(1%) irregulars.

Vertical fissure extending upwards from the inferior margin of the caudate lobe was detected in 6 specimens (12.50%). In the study of Joshi et al⁵ found an incidence of 30%. Sahni et al¹¹ revealed that fissures of variable length and positions were seen on various boundaries of the caudate lobe in 104 specimens. The existence of notch on the inferior border of caudate lobe, separating the caudate process and the papillary process, was detected in 10 specimens (20.83%). Kogure et al¹³ noticed the notch in nearly half of the patients undergoing hepatectomy. Kogure et al¹³ also recognized that the exterior notch may be a remnant of the portal segmentation of the caudate lobe.

In the present study, the transverse diameter of the caudate lobe ranged between 19.24-43.01mm while its vertical length ranged between 49.61-70.22mm and the transverse diameter of the right lobe ranged between 61.05-111.25mm and its vertical length ranged between 109.27-149.12mm. The ratio of transverse diameters of the caudate lobe to the right lobe of the liver (CT/RL ratio) was between 0.074-0.244. Compensatory hypertrophy of the caudate lobe of the liver occurs when the liver decreases, as in liver cirrhosis. The ratio of the transverse diameter of the caudate lobe to that of the right lobe of the liver becomes equal to or greater than 0.65 in cases of liver cirrhosis. The results of the current study were compared to those of Sahni et al¹¹, Chavan and Wabale¹⁴, and Arora et al.¹⁵ Arora et al¹⁵ reported that the ratio of the transverse diameter of the caudate to the right lobe ranged between 0.28-0.46, which was slightly higher than Sahni et al¹¹ (0.23-0.40). The ratio of the caudate lobe to the right lobe in this study ranged from 0.074 to 0.244, with a mean of 0.14.

LIMITATIONS

As this was a laboratory based cross-sectional study conducted in formalin fixed cadavers assembled for the dissection purpose in the department of Anatomy of National Medical College, and the real size of the liver could not be measured. Moreover, we have taken the entire liver specimen available in the department for this study. Population proportionate sampling can be done to represent the whole Nepalese population.

CONCLUSION

The caudate lobe of the liver specimens came in a variety of morphologies in this investigation, with rectangular being the most prevalent. The ratio of the transverse diameter of the caudate lobe to the transverse diameter of the right lobe of the liver (CT/RL) is used to diagnose liver cirrhosis, and the mean (CT/RL) ratio was 0.14. To rule out cystic lesions of the liver, accessory fissures of the caudate lobe must be identified.

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