

Original article:

Morphological study of caudate lobe of liver

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Abstract:

Introduction: Caudate lobe is a well demarcated anatomic segment of liver that has independent vessels in the form of portal-venous and hepatic arterial branches. Taking into consideration clinical importance of this lobe in metastasis, cirrhosis and hepatic resections a morphological study was carried out on caudate lobe of fifty liver specimens. The present study was planned to assess the anatomical independence of caudate lobe from rest of the liver and its importance in calculating the ratio for cirrhosis.

Material and methods: All parameters of caudate lobe such as size, transverse diameter were measured using vernier caliper and surface area was calculated using butter paper. Biliary drainage and venous supply were noted by gross dissection.

Observations and results: Portal venous supply only from left portal vein was found in 25/50 (50%) cases, from both right as well as left vein was found in 14/50(28%) cases, from both left portal vein and junction of two veins in 5/50(10%) cases, only from right portal vein in 3/50 (6%) cases, from the junction of two veins in 1/50(2%) cases, from left portal vein, right portal vein and also from junction of two in 1/50(2%) cases and from main portal trunk in 1/50(2%) cases.

Conclusion: The degree of anatomical independence of caudate lobe was assessed and reaffirmed. Its importance in calculating the ratio for cirrhosis on USG was reviewed.

Key words: caudate lobe, Liver cirrhosis

Introduction

The caudate lobe/Spigelian lobe/Couinaud's segment I is a well demarcated anatomic segment of liver bounded by Inferior Vena Cava (IVC) and groove for ligamentum venosus in its side to side extent and porta hepatis inferiorly.¹ Its separation is seen not only on the surface, but also on the inside, with respect to blood supply and biliary drainage. It has been subject of special attention in clinical practice due to its paradoxical behavior with respect to rest of the liver in cirrhosis. As a site of metastasis, seeding of malignancies from far and wide and ensuing hepatic resections brought it under extended scrutiny.²⁻⁶

This study was carried out to ascertain the degree of anatomical independence of caudate lobe from rest of liver, to study morphology and variations of caudate lobe to better the diagnosis and analysis of clinicopathological conditions such as cirrhosis of liver.

Materials and Methods

The study was carried out on 50 adult livers available in the department of anatomy, RMC, Loni. The study was approved by Institutional ethical committee from our university. Liver was removed enbloc from the cadavers along with intrahepatic part of inferior vena cava and structures in the lesser omentum. Livers with macroscopic evidences of disease conditions

were excluded from the study. Anatomy of the caudate lobe was studied after cleaning and defining lesser omentum covering its two of the four margins. Various parameters such as shape, size were measured. A vertical plane passing through the Midpoint of IVC was taken for determining lateral extent of caudate lobe. Presence of papillary process, notch at caudal end of lobe, biliary drainage and portal venous supply were noted by gross dissection. Surface area of caudate lobe and right lobe was measured with the help of butter paper applied on the surface of liver. The caudate lobe to right lobe ratio for surface area was calculated. To measure the transverse dimension of caudate lobe two reference points were used to determine the right (lateral) margin of the caudate lobe;

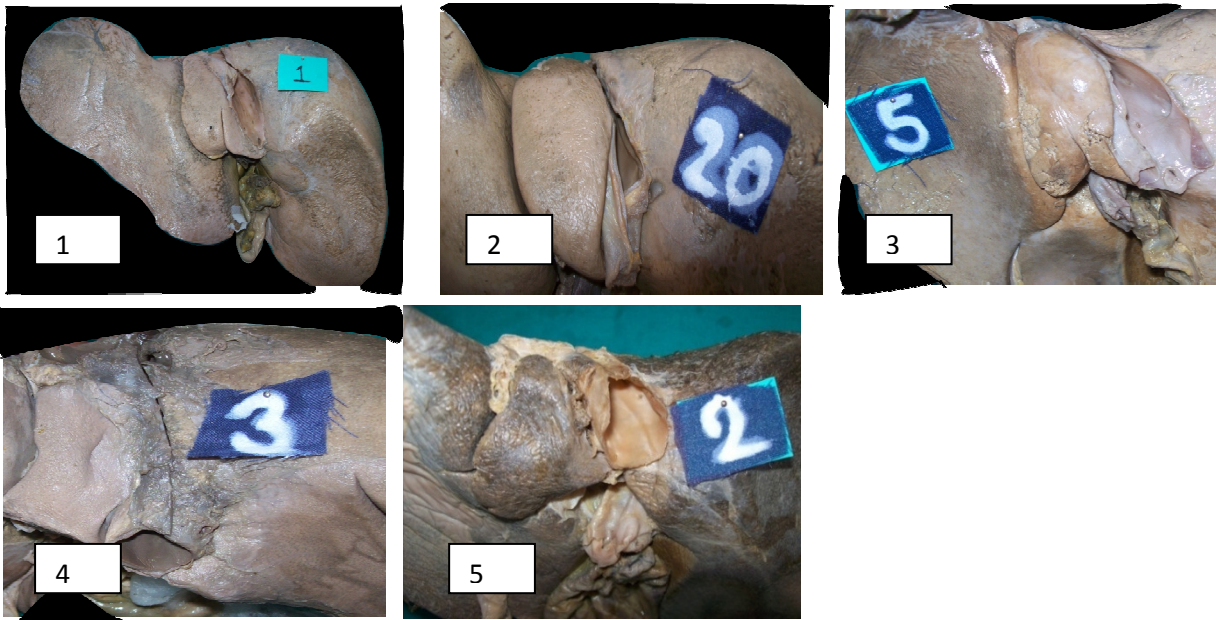
1. Right lateral margin of portal vein trunk at its bifurcation^{10,11,12}

2. Midpoint of Intrahepatic part of IVC

The measurement of the transverse dimensions of caudate lobe and similar dimensions of remaining part of right lobe was carried out using both these reference points. The ratios obtained were compared and subjected to statistical analysis. All findings were documented, photographed and compared with the findings of previous authors. Variations that we came across were noted.

Observations and Results

The caudate lobe showed wide range of variations. Out of 50 specimens 24 showed rectangular shape (48%)(figure 1), in 13 specimens it was pear shaped (26%) (figure 2), in 7 specimens it was oval (14%) (figure 3), square in 3 specimens (6%) (figure 4), triangular in 2 specimens (4%)(figure 5) and inverted flask shaped in one specimen (2%) (figure 6).



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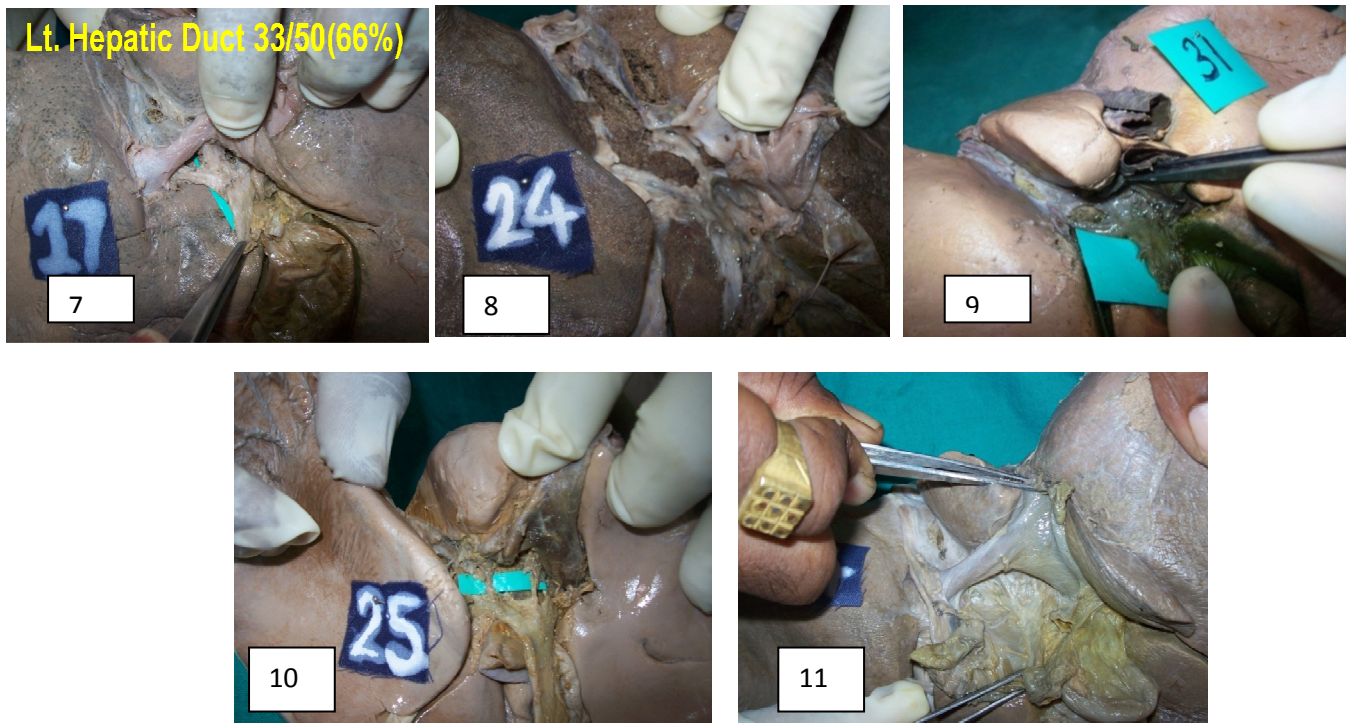
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The length of the lobe ranged between 4-9.3 cm (Average 6 cm) and width ranged between 2.5-4.2cm (Average 3.4 cm). In all cases papillary process was absent. Out of 50 specimens, 27 showed presence of notch at caudal end of lobe (54%).

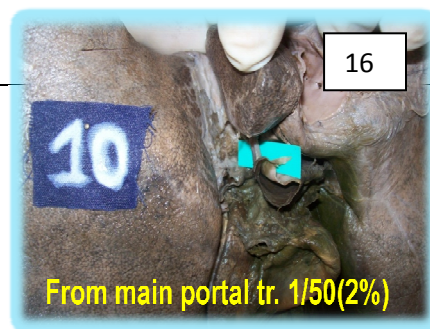
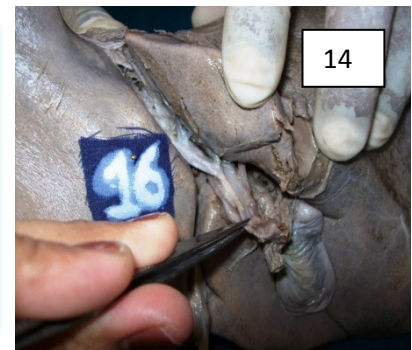
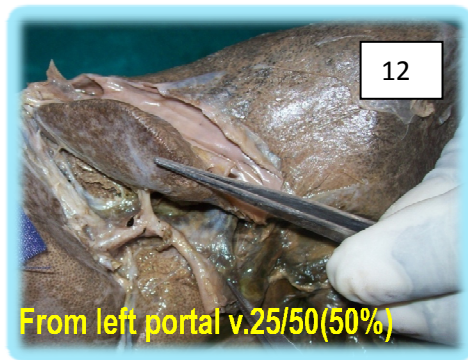
Surface area of caudate lobe ranged between 35-104 sq.cm (Average 73 sq.cm) and of right lobe ranged between 347-629 sq.cm (Average 515 sq.cm). The ratio of the two ranged 0.08-0.23 (Average 0.14). Transverse diameter measured from midpoint of Inferior Vena Cava of caudate lobe ranged between 2.5-4.2 cm (Average 3.4 cm) and of right lobe 6.7-10.5 cm (Average 8.4 cm). The ratio of the two ranged between 0.28-0.46(Average 0.33). Transverse diameter measured from right lateral wall of main portal vein just caudal to its bifurcation of caudate lobe ranged between 1.2-3.5 cm (Average 2.5 cm) and of right lobe 6.5-9.2 cm (Average 8.15

cm). The ratio of two ranged between 0.13-0.47 (Average 0.32). The difference between the two ratios of transverse dimensions was not significant. Biliary drainage to caudate lobe was from only left hepatic duct in 33 specimens (66%) (figure 7), from only right hepatic duct in 7 specimens (14%) (figure 8), from only junction of right and left hepatic duct in 7 specimens (14%) (figure 9), from junction of two ducts with additional branch from left hepatic duct in 2 specimens (4%) (figure 10), from both the ducts in 1 specimen (2%) (figure 11). The number of branches also varied. Out of 33 specimens drained by left hepatic duct, one branch was found in 31 specimens (93.93%), two and three branches in one specimen each (3.03%). In 7 specimens drained by right hepatic duct only one branch was present.



Portal venous supply to the caudate lobe was only by left portal vein in 25 specimens (50%) (figure 12), by both veins in 14 specimens (28%) (figure 13), by both left portal vein and junction of two veins in 5 specimens (10%) (figure 14), only by right portal vein in 3 specimens (6%) (figure 15), by main portal trunk, by junction of two veins, by left portal vein, junction of two veins and right portal vein in one specimen each (2%)(figure 16,17 &18). The number

of branches also varied in both veins. In left portal vein branches varied as one in 24 specimens (48%), two in 15 specimens (30%), three in 3 specimens (6%) and four in 1 specimen (2%). In right portal vein one branch was present in 14 specimens (28%) and two in 4 specimens (8%).

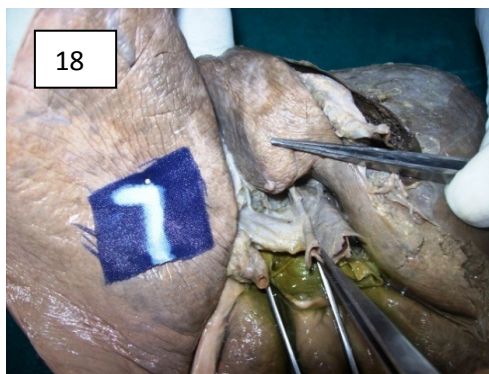


Discussion

Shape of caudate lobe shows variability in humans as well as in animals. In Ox there are only 3 lobes right, left and caudate; in a calf caudate lobe extends beyond the liver edge; in a sheep pointed caudate lobe is present and in horse triangular caudate lobe can be seen. The liver of dog consists of three lobes, the central and a left and right lateral lobe. The liver of bird has two lobes. It is dark brown coloured

(except just after hatching where it is yellow). The right lobe is larger than the left lobe. It is positioned ventral and caudal to the heart (as there is no diaphragm)²⁶.

We report the value for rectangular shape as 48% and study of Sahni et al⁷ reported it as 94.5%. The reason for this difference must be the bodily habitus due to the different set of population under study.



We noted shapes of caudate lobe as triangular, square, inverted flask shaped, oval and pear-shaped which were not reported by other studies. The papillary process when examined on CT scan can be mistaken for enlarged lymph nodes.²⁰ The papillary process was present in 33% in study of Sahni et al, which was absent in all cases of our study. Length (4-9.3 cm) and width (2.5-4.2 cm) of the lobe was comparable with study by Sahni et al {length:- (4-7.2 cm) and width:- (1.8-4.1 cm)}.

Vakili et al⁸ observed that the caudate process duct drains into the RHD (85%) and the left part of the caudate lobe drains into the LHD (93%). They stated this because of the position of the right portion of the caudate lobe, it could drain into either the left or right systems. We found that biliary drainage of the caudate lobe is by left hepatic duct in 66% cases and by right hepatic duct in 14% cases, to only junction of right and left hepatic duct in 14% cases, to junction of two ducts with additional branch from left hepatic duct in 4% cases, to both the ducts in 2% cases. Skandalakis et al⁹ observed that biliary drainage of caudate lobe only into LHD was in 15% cases and only into RHD in 5% cases. Caudate process is drained by both right and left hepatic duct. The function of the liver is to serve as a filter between the blood coming from the gastrointestinal tract and the blood in the rest of the body. Blood

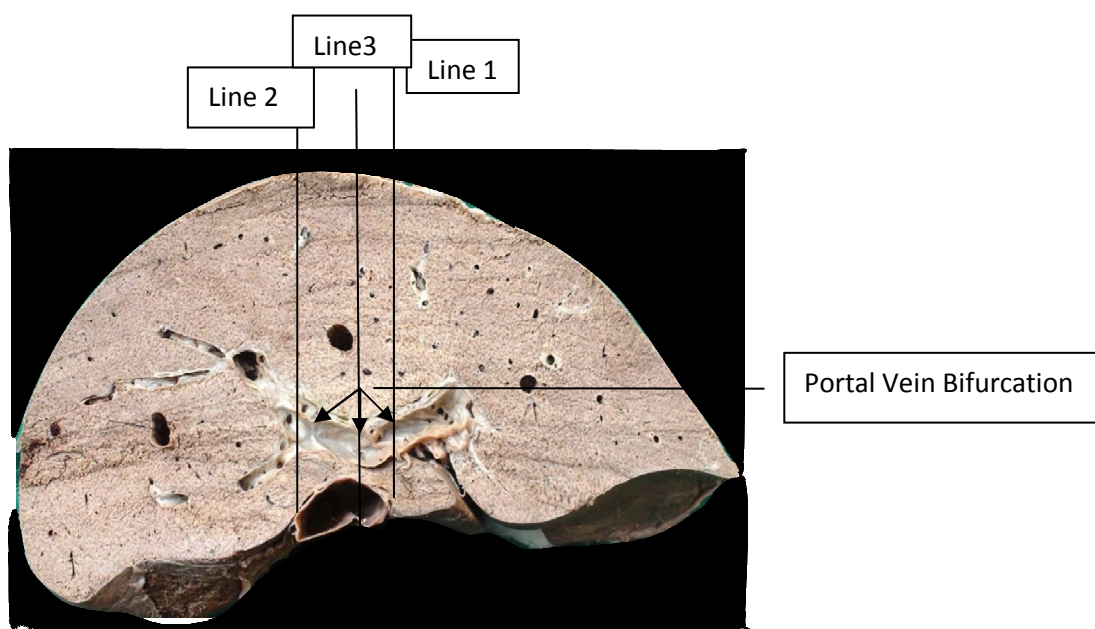
from the intestines and other viscera reach the liver via the portal vein. This blood through hepatic sinusoids and then through hepatic veins reach inferior vena cava. The portal venous pressure is about 10 mm of Hg normally. When systemic venous pressure rises, the portal vein radicles are dilated passively and the amount of blood in the liver increases. But when systemic pressure decreases, the intrahepatic portal radicles constrict, portal pressure rises and blood flow through the liver is brisk, bypassing most of the organ. Most of the blood in the liver enters the systemic circulation. Constriction of the hepatic arterioles diverts blood from the liver and constriction of mesenteric arterioles reduces portal inflow. In severe shock, hepatic blood flow may be reduced to such a degree that patchy necrosis of liver takes place.²⁴ This shows that proper oxygenation and functioning of liver cells is dependent on portal venous flow. In our set of study we found that the portal venous supply to caudate lobe by only left portal vein was in 50% cases, by both veins in 28% cases, by both left portal vein and junction of two veins in 10% cases, only by right portal vein in 6% cases, by main portal trunk, by junction of two veins, by left portal vein, junction of two veins and right portal vein in 2% cases each. The number of branches of the ducts and veins also varied.

As stated in standard books 'Caudate lobe is part of right lobe anatomically but functionally part of left lobe as it receives its blood supply from left branches of the hepatic artery and portal vein and deliver their bile to the left hepatic duct'²⁵ which is also confirmed by our study.

All the cases showed presence of independent ducts and veins for the caudate lobe. This finding suggests that caudate lobe indeed is an independent anatomical region in liver making it relatively safe from many of the afflictions of the liver. Independence of caudate

lobe is brought to existence because of its boundaries. IVC and ligamentum venosum determine its transverse extent and porta hepatis with portal vein, determine its vertical extent. Hence, IVC should be used in determining the width of caudate lobe and portal vein to determine length of the lobe. We suggest midpoint of IVC to be the parameter that shall serve as ideal parameter, that shall remain unaltered even in the event of widening or narrowing of IVC.

Photograph no.19



The ratio of transverse dimension of caudate lobe to right lobe in our study was 0.28-0.46 which was slightly higher than Sahni et al i.e.0.23-0.40. The ratio of surface area of caudate lobe to right lobe in our study was 0.08-0.23 which was comparable with that of Sahni et al 0.10-0.29. Both the above ratios indicate that in our set of population less of caudate lobe is exposed at the surface. Transverse diameter measured from right lateral wall of main portal vein just caudal to its bifurcation of caudate lobe ranged between 1.2-3.5 cm (Average 2.5 cm) and of right lobe 6.5-9.2 cm (Average 8.15 cm). The ratio of two

ranged between 0.13-0.47 (Average 0.32). The difference between the two ratios of transverse dimensions was not significant.

The caudate lobe undergoes compensatory hypertrophy when rest of the liver shrinks, as reported by many studies.^{10,11,12} This fact has been used to diagnose conditions such as cirrhosis of liver (CL/RL \geq 0.65).¹⁰ Portal vein, its bifurcation and its branches are present at the lower limit of the caudate lobe i.e. its inferior margin. Thus portal vein and its branches can be used to determine the vertical extent i.e. length of caudate lobe and should not be used to

determine the width of caudate lobe. From the photograph no.19 it is apparent that portal vein bifurcation and its branches are almost horizontal in their disposition.

The size of CL is usually given by its maximum width which most of the time in most shapes of caudate lobe is at a higher level than the main portal vein or right portal vein. There is no scientific study stating that the compensatory enlargement of caudate lobe happens only towards lower end, so main portal vein and right portal vein cannot be used to determine width of caudate lobe. Moreover while assessing the size of caudate lobe to determine liver cirrhosis, portal vein or its branches might give false reading because of dilatation due to portal hypertension affecting them. When the readings of ratio of transverse diameter of caudate lobe to right lobe with right lateral wall of main portal vein^{10,11} and with midpoint of IVC were compared, there were only negligible difference. But considering drawbacks for

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taking portal vein as standard point, our study suggests midpoint of IVC for the same. Hence, midpoint of IVC as determined on USG or other scanning methods should serve as standard reference point to find out maximum width of caudate lobe.

Conclusion:

- Caudate lobe of liver is an anatomically independent entity as is evident from our findings about its blood supply and biliary drainage.
- Shapes of caudate lobe display different patterns of variability in different populations. In our set of population less of caudate lobe is exposed to the surface.
- Midpoint of IVC should be taken as standard reference point to measure the transverse width of CL for finding CL/RL ratio, for diagnosing conditions of liver such as cirrhosis on US/CT/MRI.

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