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A Descriptive Study of Morphology of Caudate Lobe of Liver in Adult Human Cadavers in Siddhartha Medical College, Vijayawada

Dr.G.Syamala[1], Dr.Prathyush Veernala[2*], Dr.Eddu Ch Shravya[3]
[1]*Associate professor, Department of Anatomy, Siddhartha Medical College, Vijayawada*
[2*]*Senior resident, Department of Pulmonology, Guntur Medical College, Guntur*
[3]*Post Graduate, Department of Radiology, Andhra Medical College, Vishakhapatnam*
Corresponding Author: Dr.Prathyush Veernala

Abstract
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. 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.*
Materials and Methods: *This study was done on 50 formalin fixed adult human livers and collected from the cadavers which are issued for the dissection of 1st MBBS students at Siddhartha Medical College, Vijayawada, Krishna district, Andhra Pradesh.*
The gross anatomy of caudate lobe was studied for its shape, presence or absence of fissures, or notch and presence or absence of papillary and caudate processes and their variations. Caudate lobe area to right lobe area ratio (CL\RL) was also noted. The maximum transverse dimension of the caudate lobe and right lobe and the vertical extent of both caudate lobe and right lobe were measured using vernier callipers and measuring tape. The area of caudate lobes and right lobes were calculated by marking their outline on butter paper.
Results: *Caudate lobes of our study showed mainly rectangular shape (46%), columnar or elongated caudate lobes and triangular caudate lobes in equal proportion (16%) and dumbbell-shaped lobes were 14% (Table I). Papillary processes, caudate processes and notches were seen in most of the livers (77.78%). They were absent in rest of the livers studied (22.22%).*
Table II shows various measurements of the livers among the study group. A mean length of 5.4 cm and breadth of 2.58 cm were noted for the caudate lobes and mean length of 11.31 cm and breadth of 7.39 cm for right lobes respectively. Ratio of caudate lobe to right lobe area ranged from 0.06 to 0.41 with a mean of 0.17. Cirrhotic livers may show ratio over 0.65.
Conclusion: *Shape of caudate lobe is variable as is the presence of papillary processes, caudate processes and notches. Even though caudate lobe is part of right lobe anatomically, it is functionally a part of left lobe as it receives blood supply from left branches of portal vein and hepatic artery and is drained by left hepatic ducts, and is confirmed by our study*
Key Words: *caudate lobe, IVC, biliary drainage*

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I. 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]

Liver can be divided into lobes based on the bifurcation of portal vein into left and right branches. According to Couinaud, portal vein divides into left and right branches both of which divide again thus producing four main branches, each supplying a portal sector. Each portal sector is divided again by portal vein. The eight segments are numbered I to VIII clockwise from inferior vena cava. Caudate lobe is the segment I in Couinaud's classification and it is the only segment which receives blood independently from both left and right branches of portal vein. Portal vein divides into right and left branches at the hilum. Left portal branch has a

longer extraparenchymal course and tends to be slightly more horizontal than the right branch. It has horizontal and vertical portions. Horizontal portion runs along the base of segment VI and often gives branches to segment I and also to segment VI.[3]

The Glissonian sheaths to segment I arises from both right and left main sheaths. The segment therefore receives vessels independently from left and right portal vein and hepatic arteries and drain independently into inferior vena cava by multiple small branches. Bile ducts draining segment I are closely related to the confluence of the right and left hepatic ducts.[4]

Arterial blood from Hepatic artery accounts for only 20-25% of blood received by liver, is distributed initially to non-parenchymatous structures, particularly the intrahepatic bile ducts. Proper hepatic artery divides into right and left branches at the porta hepatis before they run into the parenchyma of the liver. Segmental arteries are usually end arteries and collaterals can occur between segments.[5]

Shape of caudate lobe is variable as also its anterior and upper margin. Morphology of caudate lobe has significance in diagnostic imaging and also minimally invasive surgical approaches. The caudate lobe shows compensatory hypertrophy in cirrhosis and is spared from atrophy. Thus, we have taken up this study as it may give better surgical outcome.[6]

II. Materials And Methods

This study was done on 50 formalin fixed adult human livers and collected from the cadavers which are issued for the dissection of 1st MBBS students at Siddhartha Medical College, Vijayawada, Krishna district, Andhra Pradesh.

Study Design

Descriptive study.

Diseased livers were excluded from the study. The gross anatomy of caudate lobe was studied for its shape, presence or absence of fissures, or notch and presence or absence of papillary and caudate processes and their variations. Caudate lobe area to right lobe area ratio (CL\RL) was also noted. The maximum transverse dimension of the caudate lobe and right lobe and the vertical extent of both caudate lobe and right lobe were measured using vernier callipers and measuring tape. The area of caudate lobes and right lobes were calculated by marking their outline on butter paper.

- Length of caudate lobe and right lobes were measured at the level of the maximum longitudinal extension.
- Transverse diameter of caudate lobe is the distance from the most medial margin to right lateral wall of the portal vein.
- Transverse diameter of right lobe extends from the right lateral wall of the portal vein to the most lateral margin of the right lobe.

The vessels and bile duct at porta hepatis were dissected and traced to the caudate lobe to see its supply and biliary drainage. All findings were documented.

The range of various parameters, mean and standard deviation were calculated manually.

III. Results

Morphology of Caudate Lobe

Figure 1: Rectangular

Figure 2: Dumbbell shaped

Figure 3: Triangular

Figure 4: Elongated/Columnar

Figure 5: Accesory Lobe

Figure 6: Accessory Fissure

Figure 7: 2 Branches from Left PV

Figure 8: Branches from Left and Right PV

Figure 9: BR of Left HD

S.No	Shape of Cadaveric liver	Number of Cadaveric liver	Percentage
1	Rectangular	23	46
2	Triangular	8	16
3	Columnar/elongated	12	24
4	Dumbbell shaped	7	14

Table 1: Shape of Caudate Lobes

Caudate lobes of our study showed mainly rectangular shape (46%), columnar or elongated caudate lobes and triangular caudate lobes in equal proportion (16%) and dumbbell-shaped lobes were 14% (Table I). Papillary processes, caudate processes and notches were seen in most of the livers (77.78%). They were absent in rest of the livers studied (22.22%).

Parameters	Range (cm)	Mean (cm)	SD
Vertical length of C L	3.3-8 cm	5.3	6.80
Max transverse diameter of CL	1.5-4.5 cm	2.58	0.75
Vertical length of right lobe	8-16 cm	11.31	1.96
Transverse diameter of right lobe	4.8-10 cm	7.39	1.19
Area of C L	5.25-32 cm^2	13.61 cm^2	5.7
Area of right lobe	39.36-144 cm^2	84.60 cm^2	26.15
Ratio of C L to right lobe	0.06-0.41	0.17	0.08

Table 2: Measurements of Liver

Table II shows various measurements of the livers among the study group. A mean length of 5.4 cm and breadth of 2.58 cm were noted for the caudate lobes and mean length of 11.31 cm and breadth of 7.39 cm for right lobes respectively.

Ratio of caudate lobe to right lobe area ranged from 0.06 to 0.41 with a mean of 0.17. Cirrhotic livers may show ratio over 0.65.

Vessel	Number of livers with branches from left side alone to Caudate lobe	Number of livers with branches from left side and from junction of left and right side to Caudate lobe	Number of livers with branches from both left and right sides to Caudate lobe	Number of livers with branches from junction of left and right sides to Caudate lobe
Portal vein	21	6	7	8
Hepatic artery	32	2	2	3
Bile duct	34	3	0	3

Table 3: Branching Pattern of Vessels and Ducts to Caudate Lobe

Table III shows livers with their branches of blood vessels and ducts to segment I.

Portal vein was seen to supply majority of caudate lobes through a single branch, usually from the left branch in 55.55% livers. 13.89% of caudate lobes had branches from left branch and also from junction of left and right branches. Another 13.89% livers had branches from both right and left branches supplying their caudate lobes. 6 of the caudate lobes were supplied by a single branch from the junction alone (16.67%). None of the caudate lobes in the study was supplied by the right branch of portal vein alone. One liver had 2 branches from left branch of portal vein itself.

Majority of caudate lobes had a single branch of hepatic artery from left branch supplying them (80.56%) and only 3 livers (8.33%) had supply from right branch alone. Another 8.33% had 2 branches to their caudate lobes.

Biliary drainage was mostly noted to be through a single duct from left side in our study (86.11%) as shown in chart IV.

IV. Discussion

Gross abnormalities of the liver are rare in spite of its complex development. More common abnormalities are the abnormalities in form and less common ones are the presence of accessory lobes or livers.[3] Acquired changes in liver morphology are represented by the following characteristic features, linguiform lobes, costal organ with very small left lobe, deep renal impressions and "corset" type constrictions and local inflammation of the organ or gall bladder. Accessory lobes arise most commonly from right lobe and may project in any direction. Among them, Riedel's lobe is the most common which descends inferiorly along the right lateral margin. Most of the accessory lobes and hypertrophic caudate lobe extensions and accessory fissures may disappear during postnatal changes in the liver.[7]

Accessory hepatic fissures are potential sources of diagnostic errors on both sonography and CT. Radiological and corrosion cast studies have attributed the formation of sulci to existence of weak zone of hepatic parenchyma, represented by portal fissures between adjacent sagittal portal territories. These weak zones offer a lower resistance to external pressure of diaphragm.[8]

According to Mamatha et al, notching along inferior border of caudate lobe was seen in 18% of livers studied and vertical fissures in 30%, prominent papillary process in 32%. Accessory fissures and grooves were more seen in right lobe. 60% of their study showed normal appearance. One caudate lobe in our study showed an accessory fissure (Fig.VI)

Extending from the superior surface downwards, and Papillary and caudate processes along with notches between them were seen in 77.78% of livers. An accessory lobe was also noted. Chavan[7] et al observed absence of papillary process in all their study group, whereas Sahni[8] et al reported papillary process in 33%. Kogure et al noticed notches in 50% of caudate lobes in patients undergoing hepatectomy. Singh et al observed a notch on the superior border of caudate lobe. Normal anatomy of caudate lobe can create several pitfalls that may lead mistakenly to a diagnosis of disease. Auh et al found that on CT, a normal or small papillary process may be mistaken for enlarged porta hepatis lymph nodes. Enlarged papillary process can displace gastric antrum and duodenum anteriorly mimicking right-sided retroperitoneal mass. However, Atkan et al noticed absence of caudate lobe in 7.14% of their study which was in accordance to Mamatha et al.

Caudate lobe enlargement accompanies occlusion of hepatic veins. Venous drainage of caudate lobe is by emissary veins which pass directly from caudate lobe to inferior vena cava.[9]

Shape of caudate lobe was seen to be triangular, square, inverted flask shaped, oval and pear shaped by Chavan et al. One case of dumbbell-shaped caudate lobe was seen by Mamatha et al, as in Nayak's study. Joshi et al reported 58% rectangular, 20% bicornuate, and pear shaped, quadrate, oblong, heart shaped, square, and inverted pear- shaped Caudate lobes in 22% of their study, whereas we found four different shapes of caudate lobes; which were rectangular (61.11%), columnar/elongated (16.67%), triangular (16.67%) and dumbbell shaped (5.55%). Accessory caudate lobe or caudate lobe duplication may be present.[10]

V. Conclusion

Shape of caudate lobe is variable as is the presence of papillary processes, caudate processes and notches. Even though caudate lobe is part of right lobe anatomically, it is functionally a part of left lobe as it receives blood supply from left branches of portal vein and hepatic artery and is drained by left hepatic ducts, and is confirmed by our study

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