Section: Anatomy

Original Research Article

MORPHOLOGICAL STUDY OF THE HUMAN LIVER AND ITS VARIATIONS IN THE SOUTH INDIAN POPULATION

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Abstract

Background: The liver is the second largest organ in the human body, located in the right hypochondrium, the upper part of the epigastrium and part of the left hypochondrium. The liver is anatomically divided into a larger right lobe, and a smaller left lobe. Anatomical variations are present in the cadaveric liver in the accessory lobe, accessory fissure, hypoplastic lobe etc. The knowledge of these anatomical variations will help surgeons during liver transplantation and other surgical procedures. This study aims to discuss the morphology of the adult liver and its common variations according to the Netters classification in the South Indian population. **Materials and Methods:** The present study was conducted on apparently normal liver specimens from 50 cadavers used for routine dissection by undergraduate medical students. The specimens were numbered in serial order from 1 to 50, and all the measurements were recorded and tabulated. The cadavers with no abdominal surgical scars and liver specimens with normal morphology were taken into the study. **Result:** Four of the 50 specimens studied showed accessory fissures on the diaphragmatic surface of the right lobe. Ten specimens showed accessory fissures on the visceral surface of the right lobe. Three specimens showed lingular process, and two specimens showed hypoplastic left lobe. **Conclusion:** The liver's anatomical variations remain asymptomatic but can lead to misinterpretations during radiological and surgical procedures. Detailed study of liver morphology may help surgeons and radiologists avoid misdiagnosing cystic or pathological liver lesions.

INTRODUCTION

'A good knowledge of anatomy is a prerequisite for modern liver surgery'.[1] The liver is a large wedge-shaped organ in the right hypochondrium, epigastrium and left hypochondrium.[2] The liver weighs approximately 1500 grams, 5% of the body weight in infancy and around 2% in adulthood. It receives about 1500 ml of blood per minute.[3] The liver is anatomically divided into right and left lobes by the line of attachment of the falciform ligament on the anterior surface, the fissure for ligamentum teres on the inferior surface and the fissure of ligamentum venosum on the posterior surface.[4] It is convex on all sides and concaves inferiorly, where it is moulded to the shape of the adjacent viscera.[5] In addition, the liver is also divided into caudate and quadrate lobes separated from each other by the porta hepatis.

According to the terminology of Coiunaud, the liver is divided into eight segments numbered I to VIII. Each segment has an independent artery, bile duct, tributary of hepatic vein and portal tributary. Segments I to IV comprise the left lobe of the liver, and segments V to VIII include the right lobe of the liver.[6] The liver plays an important role in carbohydrates, fat and protein metabolism. It also plays a vital role in excreting body wastes, drugs and foreign substances.[7]

In this modern imaging era, it becomes very important for clinicians and radiologists to have a thorough knowledge of the anatomy of the liver and its variations. The major fissures are important landmarks for interpreting the lobar anatomy and locating the liver lesions. The liver shows many variations, such as agenesis of individual lobes, presence of one or more accessory lobes, presence of accessory fissures etc. The presence of these variations can often mislead into a wrong diagnosis or surgical intervention.[7] Such misdiagnosis had occurred in the past; therefore, these variations should be considered during investigations.[8]

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Sound knowledge of normal liver anatomy and its variations is a prerequisite for diagnosis, investigations and surgical procedures. It is also essential for a comprehensive understanding of various liver diseases. With this background in mind, the present study was done on 50 cadaveric livers to study the morphological features and variations in the South Indian population.

MATERIALS AND METHODS

This study was done on apparently normal liver specimens from 50 cadavers used for routine dissection by undergraduate medical students after getting approval from Institutional Ethical Committee. The specimens were numbered in serial order from 1 to 50, and all the measurements were recorded and tabulated. The cadavers with no abdominal surgical scars and liver specimens with normal morphology were taken into the study. Those with abnormal morphology and disease of the liver were excluded from the study. The right and left lobes of the liver were studied in detail for size, shape, accessory lobes and accessory fissures. The following measurements were recorded on the right and left lobes of the liver.

The right lobe's transverse diameter is measured from the portal vein's right margin in the porta hepatis to the right margin of the liver by the Vernier calliper. Vertical diameter of the right lobe- measured from the mid-point of the transverse diameter of the right lobe of the liver by Vernier calliper. Transverse diameter of the left lobe - measured from the left side of the porta hepatis to the left border of the liver by Vernier calliper. Vertical diameter of the left lobe - measured from the mid-point of the transverse diameter of the left lobe of the liver by Vernier calliper.[9]

A measuring scale and tape, thread and digital Vernier calliper were used for these measurements. Variations observed were recorded and photographed. Statistical analysis: The mean, standard deviation, and range were calculated for each parameter.

The present study also classified the liver specimens according to the Netters classification. Six types of liver variations were described by Netter [Type 1 to Type 6]. The results were recorded and tabulated [Table 3].

RESULTS

The mean transverse diameter of the right lobe was 13.8 cm and ranged from 11.1 cm to 15.6 cm, with the maximum frequency from 13 cm to 14 cm. The mean vertical diameter of the right lobe of the liver was 8.4 cm in this study, with a range from 7 cm to 9.5 cm, and most of the measurements fell from 8 cm to 9 cm.

This study's mean transverse diameter of the left lobe was 12.2 cm. The transverse diameter of the left lobe ranged from 10.2 cm to 14.6 cm, with the maximum frequency from 12-12.5 cm. The mean vertical diameter of the left lobe was 7.6 cm. The vertical diameter ranged from 6.0 cm to 8.5 cm, with the maximum frequency from 7.6 cm to 8 cm [Table 1].

In the 50 liver specimens studied, normal surfaces, fissures and borders were observed in 35 (70%) liver specimens without accessory fissures or lobes. Out of the remaining 15 (30%) liver specimens, variations were identified in the right and the left lobe. These variations were recorded and tabulated [Table 2].

Accessory fissures on the diaphragmatic surface of the right lobe were seen in 8% [Figure 1 and 2], accessory fissures on the visceral surface of the right lobe were seen in 20% and equal sizes of the right and left lobe were seen in 2%. In the left lobe, accessory fissures on the visceral surface were seen in 4%, accessory lobes on the visceral surface were seen in 2%, fusion of quadrate lobe with left lobe was seen in 14% [Figure 6], and lingular process was seen in 6% [Figure 3 and 4]. The hypoplastic left lobe was seen in 4% [Figure 5&Table 2].

Table 1: Measurements of the right and left lobe of the liver.

Measurements	Mean (cm)	Standard Deviation	Range	Maximum Frequency
Transverse diameter of the right lobe	13.8	1.0	11.1 – 15.6	13 – 14
Vertical diameter of the right lobe	8.4	0.38	7 – 9.5	8 – 9
Transverse diameter of the left lobe	12.2	0.9	10.2 – 14.6	12 – 12.5
Vertical diameter of the left lobe	7.6	0.5	6.0 – 8.5	7.6 – 8.0

Table 2: Morphological Variations of Right and Left Lobe of Liver.

Variations of the right lobe	Morphological Features	No of Specimens	Percentage%
	Normal	35	70
	Accessory fissures on the diaphragmatic surface	4	8
	Accessory fissures on the visceral surface	10	20
	Equal size of the right and left lobe	1	2
Variations of the left lobe	Normal	35	70
	Quadrate lobe fused with left lobe.	7	14
	Lingular process	3	6
	Accessory fissures on the visceral surface	2	4
	Hypoplastic left lobe	2	4
	Accessory lobe on the visceral surface	1	2

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Table 3: Morphological variations of the liver according to Netter's classification.

Netter's type	No of specimen	Percentage
Type 1 (Very small left lobe, deep coastal impressions)	1	2
Type 2 (Complete atrophy of left lobe)	Nil	0
Type 3 (Transverse saddle-like liver, relatively large left lobe)	Nil	0
Type 4 (Tongue like process of the right lobe)	Nil	0
Type 5 (Very deep impressions and corset constrictions)	3	6
Type 6 (Diaphragmatic grooves)	4	8

Table 4: Showing variations of the liver in various studies

Study	Year	Accessory fissures of the right lobe[%]	Fusion of Quadrate lobe with left lobe[%]	Accessory fissures of left lobe [%]	Lingular process [%]	Accessory lobe [%]	Hypoplastic left lobe[%]
Aktan ZA et al.	2001	-	14.81	-	-	-	-
Sangeetha M et al.	2014	0	-	1.81	-	9.09	-
Wahane A et al.	2013	-	-	-	4	16	4
Khedekar DN et al.	2014	-	-	-	-	6	-
Saritha S et al.	2015	16	-	2	-	-	-
Saxena A et al.	2016	-	20		25	-	-
Tallapanenisreekanth	2016	26.66	-	4.44	-	-	-
Chaudhari HJ et al.	2017	-	-	-	-	3.7	-
Khajuria SR et al.	2018	-	-	-	6	12	-
Anbumani L et al.	2020	40	-	3.3	6.6	10	-
Anasuya DG et al.	2020	-	-	-	14	24	6
Present study	2022	28	14	4	6	6	4

Table 5: Showing variations of the liver according to Netter's classification in various studies

Study	Year	Netter's classification (in %)					
		Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Nagato AC et al.	2011	8.19	1.64	6.56	21.31	9.84	6.56
Sangeetha M et al.	2014	7	4	7	9	6	7
Saritha S et al.	2015	2	-	4	2	6	4
Saxena A et al.	2016	10	-	-	-	10	10
Chaudhari HJ et al.	2017	17.5	-	-	1.25	1.25	7.5
Anbumani L et al.	2020	-	3.3	-	6.6	-	-
Anasuya DG et al.	2020	36	8	12	14	10	28
Present study	2022	2	-	-	-	6	8

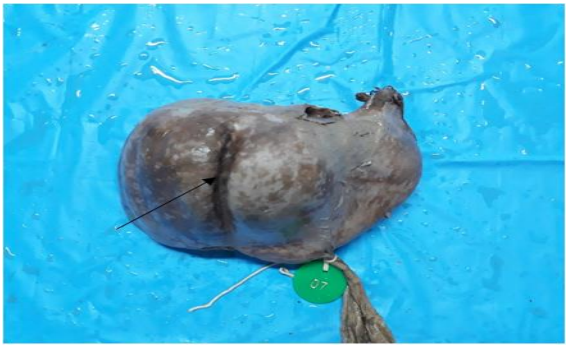

Figure 1: Liver showing accessory fissure in the diaphragmatic surface of the right lobe ( ).

Figure 2: Liver showing accessory fissures in the diaphragmatic surface of the right liver ( ).

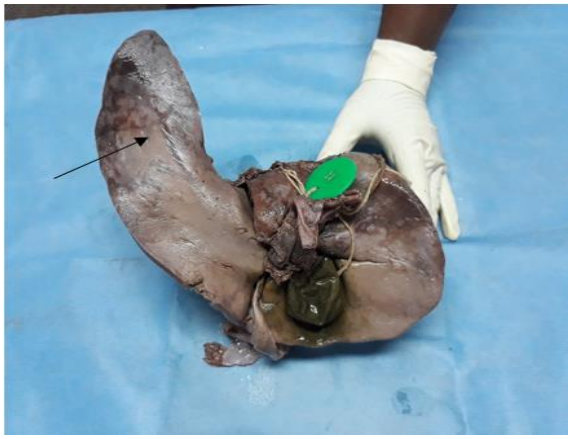

Figure 3: Liver showing Lingular Process ( ).

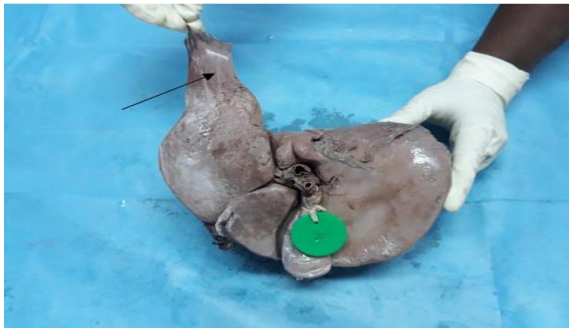

Figure 4: Liver showing Lingular Process ( ).

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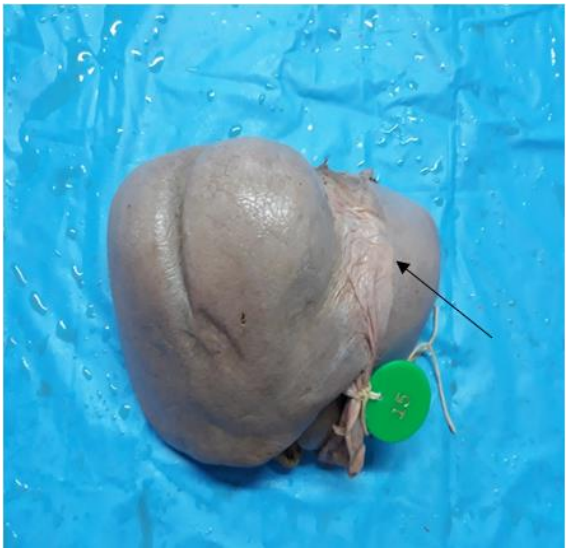

Figure 5: Liver Showing Hypoplastic Left Lobe ( )

Figure 6: Liver showing Quadrate Lobe fused with Left Lobe ( )

DISCUSSION

Congenital abnormalities or anatomical variations of the liver are mostly related to the vascular system and biliary tree changes of the liver. Common congenital anomalies are deformed lobes, atrophy of lobes, smaller lobes, agenesis of the lobes and hypoplastic lobes. External morphology of the liver is highly varied, which creates a wide range of presentations on physical examination, radiologic imaging and post-mortem studies.

Morphological study of the liver

Various authors did the morphological study of the liver, and the results of the present study were compared with them.

The mean transverse diameter of the right lobe of the liver was observed to be 13.8cm, which was equal to the report of Joshi MM et al.[10] The mean vertical diameter of the right lobe of the liver was observed to be 8.4 cm, which was closer to the report of Joshi MM et al. (2017).[10]

The mean transverse diameter of the left lobe was 12.2 cm, and the mean vertical diameter of the left lobe was 7.6 cm, equal to the report of Joshi MM et al (2017).[10]

Variations of the liver:

In 50 liver specimens studied, multiple variations like accessory lobes, accessory fissures, lingular process of left lobe, and fusion of quadrate lobe with left lobe were identified and tabulated. The results were compared with studies by various authors.

In the present study, the accessory lobes were noted in 6%, equal to Khedekar DN et al.[11] [Table 4].

The accessory lobe commonly arises from the right lobe, and these lobes risk torsion.[12] When the liver's accessory lobe is small, it may be mistaken for a lymph nodule.

In the present study, accessory fissures were noted in lobes. In the right lobe, accessory fissures were present in 28%, and in the left lobe, accessory fissures were present in 4%, almost equal to the report of Tallapaneni Sreekanth [Table 4].[13]

The multiple accessory fissures may mimic pathologic macro nodular liver on CT. These fissures may be associated with diaphragmatic scalloping or eventration on a chest film. Fluid collection in these fissures may be mistaken for liver abscess, cyst, intrahepatic hematoma or implantation of disseminated tumor cells. The invagination of the muscular diaphragm forms the fissures into the liver on the coastal surface. These accessory fissures may cause errors in diagnosis in imaging modalities. These fissures are areas of reduced vascularity and play an important role during segmental resection of the liver.[14]

In the present study, a hypoplastic left lobe was noted in 4%, equal to the reports of Wahane A et al.[15]Lingular process was noted in 6%, which was closer to the reports of Abhilasha Wahane A et al.[15] The lingular process of the left lobe could be mistaken for subcapsular splenic hematoma. Fusion of the left lobe and the quadrate lobe was noted in 14%, which was closer to the reports of Aktan Z A et al [Table 4].[16]

Netter's Classification.[17]

The lobes of the liver were studied in detail and classified according to Netter's classification and correlated with other studies.

In the present study, Netter's type 1 was seen in 2%, which was equal to Saritha S et al.[18] Type 2 was absent, which was similar to Saritha S et al,[18] Saxena A et al,[19] and Chaudhari HJ et al,[20] type 3 was also absent, which was similar to Saxena A et al,[19] and Chaudhari HJ et al,[20]Anbumani L et al.[21] Type 4 was absent, similar to Saxena A et al.[19] Type 5 was seen in 6%, which was equal to Saritha S et al,[18] Sangeetha M et al,[22] and type 6 was seen in 8%, which was lesser than Saritha S et al,[18] Chaudhari HJ et al,[20] and Sangeetha M et al [Table 5].[22]

As most of the diagnosis and treatment of liver pathologies like laparoscopic procedures (like hepatectomy and ablation) depend primarily on

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radiological imaging, detailed knowledge of the liver's anatomical variation is essential for surgeons and radiologists to prevent wrong interpretation in the diagnosis.

CONCLUSION

The knowledge of variations of the liver like agenesis, atrophy, presence of accessory lobes or fissures can prevent diagnostic errors in interpretations by radiologists and surgeons. Awareness of these variations helps to avoid fatal complications. It helps in planning appropriate surgical approaches. It also serves as a guide for proper interpretations of liver images using various imaging modalities.

These findings assume more importance to an anatomist, surgeons during hepatic segmentation and radiologists. The knowledge of the liver may be of immense use to clinicians in diagnosing and managing hepatic diseases and to embryologists for early intervention. These variations are also important in cases of laparoscopic removal or thermal ablation of liver mass.

REFERENCES

1. Bismuth H. Surgical anatomy and anatomical surgery of the liver. In.Blumgart LH, editor. Surgery of the liver and biliary tract [CD-ROM]. Edinburgh [UK]; Churchill Livingstone: 1994.
2. Susan Standring's Gray's Anatomy: The Anatomical Basis of Clinical Practice 41st ed., pg no.1160-1171.
3. Wright & Alison (1984); Adult hepatic progenitor cell dx.doi.org /10.5772/58814; page no.174.
4. Langman's medical embryology 12th edition; page no. 217-218
5. P L Wiliams; R Warwick; M Dysonand L H Bannister, Gray's Anatomy, Churchill, Livingstone, Edinburgh, U K; 38th edition 1995.
6. Textbook of Anatomy – Neetha Kulkarni – 3rd edition – volume 2; page no. 547
7. Joshi SD, Joshi SS, Athavale SA. Some interesting observations on the surface features of the liver and their clinical implications. Singapore Med J. 2009; 50:715-19.
8. Fitzgerald, R; Hale, M & Williams, C.R. Case report accessory lobe of the liver mimicking lesser omental lymphadenopathy. Br. J. Radiol. 1993; 66: 839-41.
9. Arora NK, Srivastava S, Haque M, Khan AZ, Singh K. Morphometric study of Caudate Lobe of Liver. Int Med Dent Res 2016; 2:275.
10. Joshi MM, Chavan SK. Morphological study of the adult human cadaveric liver. Int J Anat Res. 2017; 5:4284-89.
11. Khedekar DN, Hattangdi SS. Some interesting morphological features of liver lobes in the Mumbai population. Int J Med Res Health Sci. 2014; 3:656-9.
12. Royer MF, Vias BilliaresePancreas, GuanbaraKoogan, Rio de Janeiro, Brazil, 1959.
13. Tallapaneni Sreekanth. Diaphragmatic Fissures and Accessory Sulci of Liver in the Population of Telengana. Int J Anat Res 2016, 4; 3273 –78.
14. Macchi V, Porzionato A, Parenti A, Macchi C, Newell R, De Caro R. Main accessory sulcus of the liver. Clin Anat 2005; 18:39–45.
15. Wahane A, Satpute C. Normal morphological variations of liver lobes: A study on the adult human cadaveric liver in Vidarbha region. Int J Sci Res. 2015; 4:814-6.
16. Aktan ZA, Savas R, Pinar Y, Arslan O. Lobe and segment anomalies of the liver. J Anat Soc India. 2001; 50:15-6.
17. Netter FH. Atlas of Human Anatomy. 2ed. New York: 18 Guilford Press, 2000.
18. Saritha S, Ramani, Nagajyothi, Yesender. A cadaveric study of morphological variations in the human liver and its clinical importance. Int J Med Sci Clin Inventions. 2015; 2:1020-31.
19. Saxena A, Agarwal KK, Jakhwal C, Singh S, Das AR. Some variable facts of the liver: an embryological and clinical perspective. Int J AnatRadiol Surg. 2016; 5:64-7.
20. Chaudhari HJ, Ravat MK, Vaniya VH, Bhedi AN. Morphological study of human liver and its surgical importance. J. Clin. Diagnostic Res: JCDR. 2017; 11:AC09.
21. Anbumani L, Pavazhakkurinji TN, Thamaraiselvi A. Morphological study on the variation of an external liver surface. Int J Anat Res. 2020; 8:7481-5.
22. Sangeetha M, Varalaksmi K.L, ShilpaNaik – A study of the morphometry of the liver – Int J Applied Res. 2014; 4:2249 – 555X.
23. Khajuria SR, Agarwal RK, Saini H. Study of morphological variations in human cadaveric livers. Int J Anat Res 2018; 6:5072–5.
24. Anasuya. DG, Eben Raj TJ, Jeevamani MS. The queer variations in the human liver and recent insights into their clinical importance. Int J Anat Res 2020; 8:7722–7.
25. Nagato AC, Silva MA, Trajano ET, Alves JN, Bandeira AC, Ferreira TA, Valença SD, Bezerra FS. Quantitative and morphological analyses of different types of human liver. J Morphol Sci. 2011; 28:275-9.

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