Section: Anatomy

Original Research Article

MORHOLOGICAL STUDY OF RIGHT AND LEFT LOBES OF HUMAN CADAVERIC LIVER AND ITS VARIATIONS

Molly A J[1], Sreekala U S[2], Shihas P M[3], Anagha V S[4]

[1]Assistant Professor, Department of Anatomy, Govt. T. D. Medical College, Alappuzha, Kerala, India.
[2]Assistant Professor, Department of Anatomy, Govt. T. D. Medical College, Alappuzha, Kerala, India.
[3]Associate Professor, Department of Anatomy, Govt.T. D. Medical College, Alappuzha, Kerala, India.
[4]Assistant Professor, Department of Anatomy, Govt. T. D. Medical College, Alappuzha, Kerala, India.

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Corresponding Author:
Dr. Anagha V S,
Assistant Professor, Department of Anatomy, Govt. T. D. Medical College, Alappuzha, Kerala, India.
Email: anaghavs@gmail.com

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ABSTRACT

Background: The liver is the largest wedge shaped abdominal viscera. It weighs approximately 2% of body weight in adult. It is anatomically divided into right and left lobes. The knowledge of normal and variant Anatomy of liver is important during radiological investigation and surgery. Variations in the liver morphology can be either congenital or acquired.

Materials and Methods: This Descriptive study was conducted in 40 adult human cadaveric liver obtained from routine dissection done by under graduate and post graduate students in the Department of Anatomy, Government T. D. Medical College, Alappuzha. Intact human cadaveric liver with no obvious damage were studied and liver with any damage were excluded.

Results: Based on Netter's classification, type1 (normal) was observed in 11 (27.5%) specimens, type 2 in 7 (17.5%) and type 4 in 9 (22.5%) liver specimens. Type 5 (reidel's lobe) was observed in only one (2.5%) specimen. Type 6 was seen in 7 (17.5%) specimens and type 7 in 16 (40%) specimens. No liver with complete atrophy of the left lobe was observed. Accessory fissures were observed in 26 right lobes (65%). Accessory lobes of right lobe were noticed in 3 specimens. Diaphragmatic grooves (40%) and deep renal impressions (17.5%) were seen as the features of right lobe. Accessory fissures and accessory lobes of left lobe were noticed in 15% and 5% respectively. Elongated (22.5%) and hypoplastic left lobes (17.5%) were also noticed. In the present study, mean transverse diameter of right and left lobes were 8.22±1.08cm and 7.43±1.58cm respectively. Mean vertical diameter of right lobe was 12.29±2.17cm and that of left lobe was 12.14±3.28cm.

Conclusion: The knowledge of normal and variant Anatomy of liver is important during radiological investigation and surgery. Variations in the liver morphology can be either congenital or acquired. Awareness of these variations would help both the surgeons and radiologists to avoid misdiagnosis of cases and unnecessary surgical complications. This study also helps to enlighten the knowledge of anatomists to facilitate teaching.

Keywords: Variations of liver, Right lobe, Left lobe, Accessory fissures, Accessory lobes, Riedel's lobe.

INTRODUCTION

The liver is the largest wedge shaped abdominal viscera in the right hypochondrium, epigastrium and left hypochondrium. It weighs approximately 2% of body weight in adult. It 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 hepatis on the inferior surface and fissure for ligamentum venosum on the posterior surface. In addition, liver has caudate and quadrate lobes. According to Coinaud, 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. Three minor fissures, umbilical, venous and fissure of Gans are visible as physical clefts in the liver surface.[1]

The knowledge of normal and variant Anatomy of liver is important during radiological investigation and surgery. Variations in the liver morphology can be either congenital or acquired. The congenital abnormalities of the liver include agenesis, atrophy or hypoplasia of lobes, accessory lobes and accessory fissures. Most of the accessory fissures disappear during the liver reformation in the post natal period but some can persist for life. Congenital variations can be due to defective development or excessive development of hepatic parenchyma. Acquired variations in liver like diaphragmatic grooves, deep renal impressions could be due to the pressure given by diaphragm, peritoneal ligaments and other organs in relation with liver so developed during lifetime of a person. Awareness of these variations would help both the surgeons and radiologists to avoid misdiagnosis of cases and unnecessary surgical complications. This study also helps to enlighten the knowledge of anatomists to facilitate teaching.

MATERIALS AND METHODS

This Descriptive study was conducted in 40 adult human cadaveric liver obtained from routine dissection done by under graduate and post graduate students in the Department of Anatomy, Government T D Medical College, Alappuzha. Intact human cadaveric liver with no obvious damage were studied and liver with any damage were excluded.

The parameters were measured using measuring tape. External features of liver were observed and categorized according to the Netter's classification. Transverse diameter of the right lobe was measured from the right margin of portal vein in porta hepatis to the right margin of the liver by using measuring tape. Vertical diameter of the right lobe was measured from the upper margin to lower margin along the midpoint of the transverse diameter of the right lobe of the liver by using measuring tape.

Transverse diameter of the left lobe was measured from the left side of the porta hepatis to left border of the liver by using measuring tape. Vertical diameter of the left lobe was measured from the upper margin to the lower margin along the midpoint of the transverse diameter of the left lobe of the liver by using measuring tape.

The number and percentage of each morphological feature were recorded. The numerical data were summarized as arithmetic mean and standard deviation.

RESULTS

VARIATIONS IN GROSS FEATURES OF LIVER BASED ON NETTER'S CLASSIFICATION

Based on Netter's classification, type1 (normal) was observed in 11 (27.5%) specimens, type 2 in 7 (17.5%) and type 4 in 9 (22.5%). type 5 (reidel's lobe) was observed in only one (2.5%) specimen. Type 6 was seen in 7 (17.5%) specimens and type 7 in 16 (40%) specimens. No liver with complete atrophy of the left lobe was observed.

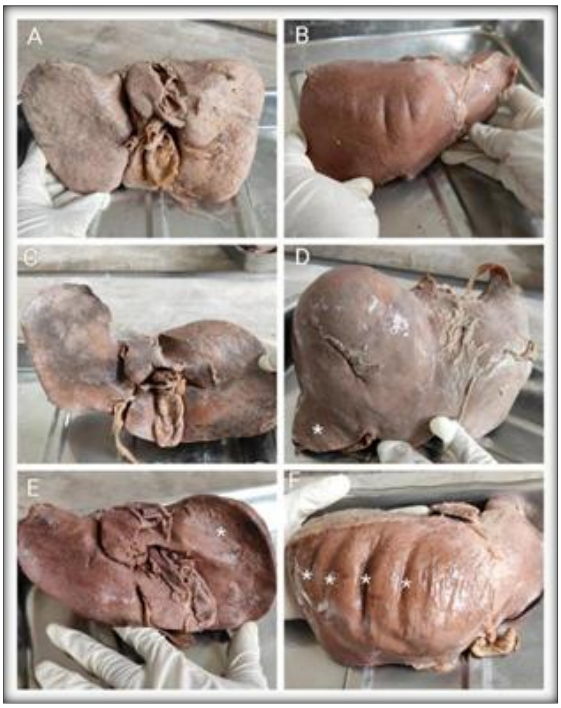

Figure 1: Livers categorised on the basis of Netter's classification.

A: Netter's Type 1 liver (normal characteristics);B: Netter's Type 2 liver (small left lobe with deep costal impressions);C: Netter's Type 4 liver (Transverse saddle like liver and relatively large left lobe); D: Netter's Type 5 liver (Tongue like process of right lobe(Reidel's lobe); E: Netter's Type 6 liver (Very deep renal impressions and corset constriction);F: Netter's Type 7 liver(Diaphragmatic grooves on the surface).

Accessory fissures in the right lobe of the liver

The proportion of accessory fissures was substantially higher on right lobe than left lobe. These

accessory fissures were observed in 26 right lobes (65%).

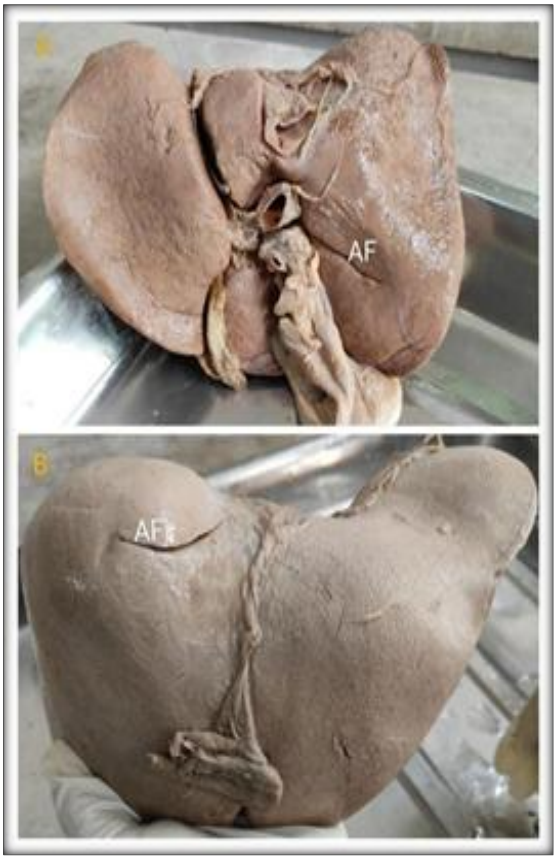

Figure 2: A: Accessory fissure in visceral surface of right lobe of the liver (Rouvier's sulcus)
B: Accessory fissure in anterior surface of right lobe of the liver

Accessory lobes of right lobe of the liver

These were noticed in 3 specimens (7.5%). Tongue like projection of the inferior border of the right lobe (Riedel's lobe) was seen in 1 specimen (2.5%).

Figure 3: Accessory lobe in right lobe of the liver

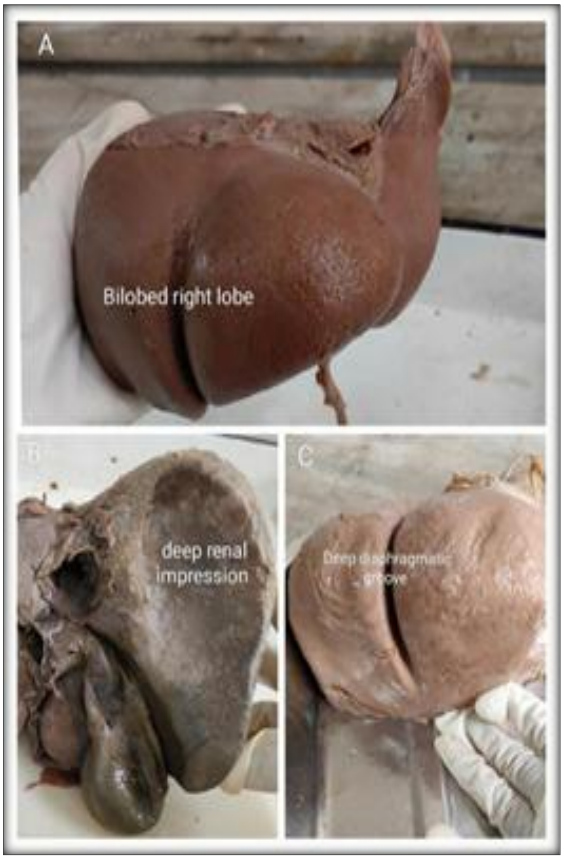

Figure 4: Depicting external features of right lobe of the liver
A: Bi-lobed right lobe produced by corset constriction
B: Deep renal impression; C: Deep diaphragmatic groove

Figure 5: Accessory fissures in left lobe of the liver

Figure 6: Accessory lobe in left lobe of the liver

Figure 7: Various forms of elongated left lobe of liver
A: Linguiform (tongue like projection); B: Leaf like; C: Spatular; D: Wedge shaped

Figure 8: Hypoplastic left lobe of the liver

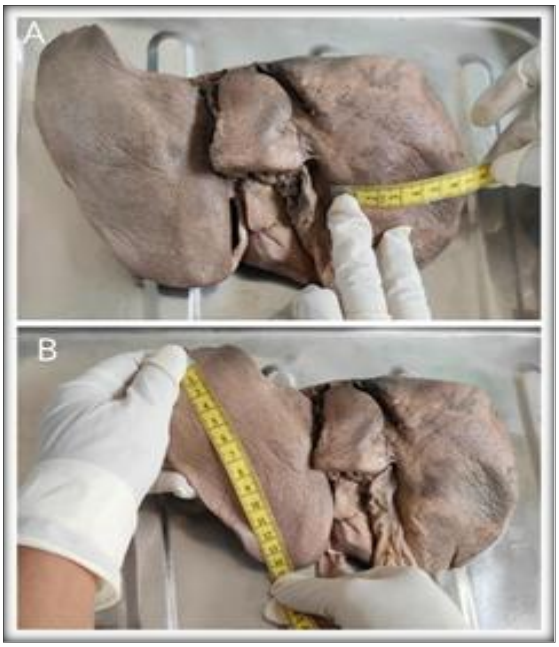

Figure 9: Methods of taking measurements of right and left lobes by using measuring tape
A: Transverse diameter of right lobe of the liver.
B: Vertical diameter of left lobe of the liver.

Table 1: Gross variations of the liver in accordance with Netter's anatomical classification

	Gross Description	Number	Percentage
Type 1	Normal	11	27.5%
Type 2	Very small left lobe,deep costal impressions	7	17.5%
Type 3	Complete atrophy of the left lobe	-	-
Type 4	Transverse saddle like liver,relatively large left lobe	9	22.5%
Type 5	Tongue like process of right lobe	1	2.5%
Type 6	Very deep renal impressions and corset constriction	7	17.5%
Type 7	Diaphragmatic grooves on the surface	16	40%

MORPHOLOGICAL VARIATIONS OF RIGHT LOBE OF THE LIVER

Table 2: Morphological variations of right lobe of the liver

Morphological features	Number	Percentage
Accessory fissures	26	65%
Accessory lobes	3	7.5%
Diaphragmatic grooves	16	40%
Deep renal impression	7	17.5%

Table 3: Measurements of right lobe of the liver

Parameters	Mean±SD	Range
Transverse diameter	8.22 ±1.08	6.3-10.9
Vertical diameter	12.29±2.17	8.4-17.2

MORPHOLOGICAL VARIATIONS OF LEFT LOBE OF THE LIVER

Table 4: Morphological variations of left lobe of the liver

Morphological variations	Number	Percentage
Accessory fissures	6	15%
Accessory lobes	2	**5%**
Elongated left lobe	9	22.5%
Hypoplastic left lobe	7	17.5%

Table 5: Measurements of left lobe of the liver

Parameters	Mean±SD	Range
Transverse diameter	7.43 ±1.58	5.4-14.2
Vertical diameter	12.14±3.28	8.1-22.4

DISCUSSIONS

There have been significant recent developments in liver transplantation and introduction of advanced imaging methods. These developments have mandated the need for better understanding of hepatic anatomy and its variations.

In the present study, out of 40 liver specimens, 11(27.5%) were type 1(normal). All types of liver based on Netter's classification were observed except type 3. 9 liver specimens showed the features of more than one type of liver based on Netter's classification. Frequency of type 6 and type 7 livers were more in our study compared to previous works done by other authors.

Table 6: Comparison of morphological categories of liver in various studies according to Netter's classification

Authors	Sambhav et al[2] (2023)	Sangeeta et al[3] (2021)	Anasuya et al[4] (2020)	Chaudhari et al[5] (2017)	Present study
Netter's type 1	55%	56%	-	-	27.5%
Netter's type 2	10%	8%	36%	17.5%	12.5%
Netter's type 3	-	-	8%	-	-
Netter's type 4	17.5%	8%	12%	-	22.5%
Netter's type 5	2.5%	8%	14%	1.25%	2.5%
Netter's type 6	7.5%	4%	10%	1.25%	17.5%
Netter's type 7	7.5%	20%	28%	7.5%	40%

ACCESSORY FISSURE

Accessory fissures are the potential sources of diagnostic errors during imaging. On ultra sound and computed tomography scans, it may be mistaken for a liver cyst, hematoma or abscess when there is collection of fluid in these fissures. Metastatic tumour cells getting lodged into these spaces may mimic intrahepatic focal lesions.

Accessory fissures present on the visceral surface of the right lobe is called 'Rouviere's sulcus' or 'Fissure of Gantz' or 'incisura hepatis dextra'. Identification of Rouviere's sulcus can be helpful to avoid bile duct injury during laparoscopic cholecystectomy and segmental resection as it aids in recognition of biliary pedicle.[2] In cases of abdominal trauma, imaging or direct palpation of sulcus prior to laparotomy may give a false impression of a liver laceration.[6]

The present study showed accessory fissures in right lobe and left lobe in 65% and 15% respectively. Sambhav et al,[2] in their study on 40 liver specimens have identified 72.5% accessory fissures in right lobe and 30% in left lobe. Anbumani et al,[7] observed accessory fissures in both right and left lobes of the liver in 40% and 3.3% respectively. In the study conducted by Priyanka N Sharma et al,[8] reported accessory fissures on right lobe in 13 (17.33%) specimens and left lobe in 1 (1.33%) specimen.

Accessory fissures on right lobe of the liver have been notified as the commonest variations of hepatic lobe morphology by various authors in different studies. Our findings were in accordance with them.

DIAPHRAGMATIC GROOVES

The first description of diaphragmatic groove is probably attributed to Zahn in 1882. The so- called 'Zahn's grooves' can be found on the diaphragmatic

surface, predominantly on the right lobe of liver. These are a result of uneven growth of the hepatic parenchyma caused by variable resistance offered by the ribs or the muscle bundles of the diaphragm. It is also referred to as 'Cough furrows' as it is seen in chronic lung conditions like asthma, COPD with cough as predominant symptom, producing diaphragm hypertrophy. 'Corset liver' or ribbed liver is another condition that can cause diaphragmatic grooves in individuals wearing corset to correct skeletal deformity for a long period or to get desired figure.[9] Macchi et al,[10] suggested that the diaphragmatic sulci could be a good landmark for projection of portal fissures and of the hepatic veins with their tributaries running through them.

Diaphragmatic groove (type7) was the second commonest variation (40%) seen in our study. Our findings agreed with the previous observations. [Table 2]

ACCESSORY LOBES OF THE LIVER

Apart from the normal lobes, the presence of any extra lobe is called as accessory lobes. These can be of two types., an accessory lobe joined to normal hepatic tissue or lobe that is completely separate. It may be pedunculated or sessile. Embryologically, accessory lobes are formed by the displacement of the primitive rudiment of the organ or by the persistence of the mesodermal septa during proliferation, which occurs due to defective formation of the caudal foregut and hepatic bud. Based on the location of accessory lobes, clinical symptoms may vary.[11]

Riedel's lobe is one of the well described accessory lobe. It is a downward tongue like projection of the anterior edge of the right lobe of the liver to the right of the gall bladder. This variant was first described by Corbin in1830 and defined by Reidel in 1888, based on the result of his surgical patients with palpable right hypochondrial mass. It can become symptomatic, causing abdominal discomfort, palpable right upper quadrant mass and rarely can present with complications such as torsion in pedunculated form. It may be mistaken for lymph node and accidentally removed during surgery which would result in excessive bleeding due to damage to the vascular pedicle of the liver lobe.[12]

In the present study, we observed accessory lobes in 3 (7.5%) specimens in right lobe and 2 (5%) specimens in left lobe. Incidence of Reidel's lobe was noted in one specimen (2.5%). Chaudari et al.[5] found Reidel's lobe in 1.25% specimens and Sambhav et al.2 observed in one specimen (2.5%).

The result of the present study endorsed the results of the above works.

ELONGATED LEFT LOBE OF THE LIVER

Beaver tail liver' is an elongated left lobe of the liver that extends laterally to contact and surround the spleen .This is also known as 'silver liver' and is more common in females. It can be associated with abnormal epigastric pain. It may be misdiagnosed as a splenic trauma, subcapsular hematoma, or a perisplenic hemorrhage within the splenic parenchyma, as it may be difficult to differentiate liver and spleen from each other when echogenicity or density on USG and CT are equivalent.[13]

In the present study, elongated left lobe of the liver was noted in 9 (22.5%) specimens. Sambhav et al,[2] noticed elongated left lobe in 12.5% specimens. H R Singh et al14 reported presence of Beaver's lobe in 12.86% specimens. Chaudhari et al5 found elongated left lobes in,[10] (12.5%) specimens. Out of 75 specimens 7 showed elongated left lobe in the study conducted by Sharma et al.8 Such variations had been reported by various authors which were concordance with the present study.

HYPOPLASTIC LEFT LOBE OF THE LIVER

The left lobe is anatomically smaller than the right lobe. The left lobe extends towards the fundus of the stomach and helps to keep the stomach in position. Congenital anomalies of liver was first described by Haller in1870. Left lobe involvement is more frequent than the right lobe. Normally hypoplastic lobes of liver were seen to be asymptomatic. It can be associated with gastric volvulus. Incidence of these anomalies is more commonly seen in males.[15]

In the present study, we identified hypoplastic left lobe in 7(17.5%) specimens. Sambhav et al,[2] observed small left lobe in 4 (10%) specimens. Anasuya et al,[4] found hypoplastic left lobe in 6% liver specimens. Seeja et al,[16] noticed hypoplastic left lobe in 4% specimens. Swathi poornima et al,[6] reported hypoplastic left lobe in 5 (11.9%) specimens. The findings of the previous works were similar to the results of our study.

MEASUREMENTS OF RIGHT AND LEFT LOBES OF THE LIVER

Table 7: Comparison of gross measurements of right and left lobes of the liver with other studies

Measurement categories	Sambhav et al[2]	Seeja et al[16]	Deshwal et al[17]	Current study
Transeverse diameter of right lobe (cm)	6.7-11.5	11.1-15.6	9.4-17.6	6.3-10.9
Vertical diameter of right lobe (cm)	10.2-26	7.0- 9.5	11.5-18	8.4-17.2
Transeverse diameter of left lobe (cm)	4.6-10.5	10.2-14.6	6.0-10	5.4-14.2
Vertical diameter of left lobe (cm)	7.8-27	6.0- 8.5	9.0-20	8.1-22.4

Transverse diameter and vertical diameter of right lobe were more than that of left lobe in above studies which are similar to the present study.

CONCLUSION

Awareness of morphology of the liver like presence of accessory lobes, accessory fissures, Netter's classification of liver and diameters of right and left lobes of the liver helps in planning appropriate surgical approaches, laparoscopic removal or thermal ablation of liver mass. It also serves as a guide for proper interpretations of liver images using various imaging modalities. This study also helps to enlighten the knowledge of anatomists to facilitate teaching.

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