Original Article

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The Study of Morphological Variations of Liver in Human Cadavers

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Abstract

Background: Liver is the largest gland and second largest organ in the human body. Anatomically, it consist of two lobes right and left seperated from each other by ligaments. Two additional lobes caudate and quadrate lobe are seen on the posterior and inferior surface of liver respectively. *Aim:* To observe and analyse the type and frequency of variations in liver morphology. *Study Design:* Observational study. *Materials and Methods:* The study was conducted on 80 liver specimens obtained during routine dissection of undergraduate students. *Statistical analysis used:* Descriptive statistics. *Results and Conclusions:* Out of 80 specimens, 56 specimens showed normal fissures and lobes. The rest of the 24 specimens showed morphological variations. The findings of the present study will be helpful for the radiologist, surgeons and anatomists.

Keywords: Liver; Lobes; Morphology.

Introduction

Liver is the largest gland in the human body. It is located in the right hypochondriac, epigastric and left hypochondriac region of the upper abdominal cavity under the right dome of diaphragm. Anatomically, it is divided in to right and left lobe by the attachment of falciform ligament anterosuperiorly, fissure for ligamentum venosum posteriorly and fissure for ligamentum teres hepatis inferiorly. Apart from right and left lobe, liver has two additional lobes namely caudate lobe with caudate process and papillary process on the posterior surface and a rectangular quadrate lobe on the inferior surface [1]. A sound knowledge of normal and variant livers is mandatory for the surgeons in planning and performing surgical procedures, for the radiologist to prevent possible misdiagnosis and for the anatomists to find out new variants.

The major fissures of liver are important landmarks for interpreting the lobar anatomy and locating the liver lesions. Although the segmental anatomy of the liver has been extensively researched, very few studies have dealt with the surface variations of the liver [2]. Hence, this comprehensive study was conducted to observe and note the variations on the surface of the liver.

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Materials and Methods

Specimens were obtained from cadavers utilized for routine dissection of medical undergraduate students in the anatomy dissection hall and then preserved in 10% of formalin. This was an observational study conducted on 80 liver specimens. Apparently normal livers which were free from any disease were included in the present study. Livers with any pathology or damage were excluded. The morphological variants were observed and photographed. Morphological variations of liver include presence of accessory fissures, presence of accessory lobes, abnormal size and shape of lobes and absence of lobes. Data was analysed using descriptive statistics. Frequency was calculated in terms of percentage.

Results

In the present study, out of 80 liver specimens, 56 specimens showed normal fissures and lobes. The

rest of the 24 specimens showed morphological variations. A very interesting observation was that many livers had more than one surface variation.

Table 1: Showing frequency of variations in different lobes of liver

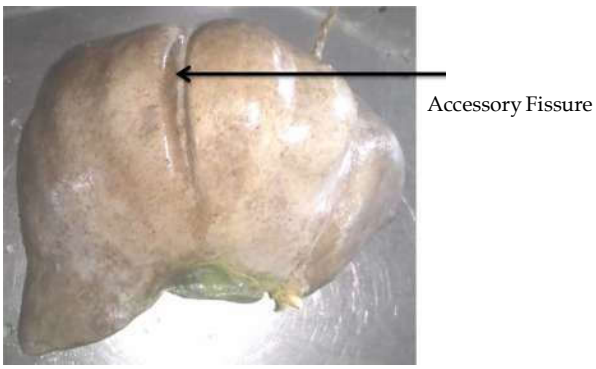
Lobe	Frequency
Right lobe	12.5% (10 specimens)
Left lobe	10% (8 specimens)
Caudate lobe	3.75% (3 specimens)
Quadrate lobe	3.75% (3 specimens)

Accessory fissures were observed on the right lobe of liver in 10 (12.5%) specimens.

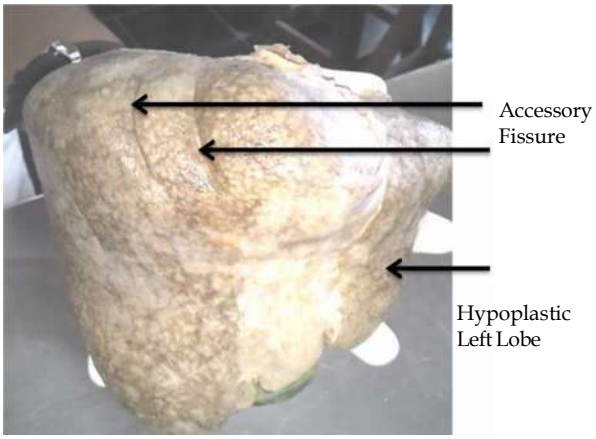
The fissures were localized on the anterior and superior surface of the right lobe.

They were narrow with variable depths ranging from 0.5cm to 2cms & variable in number (1–5 fissures) (Picture A, B).

An accessory fissure separating caudate process from papillary process was observed in 1 (1.25%) specimen (Picture C).



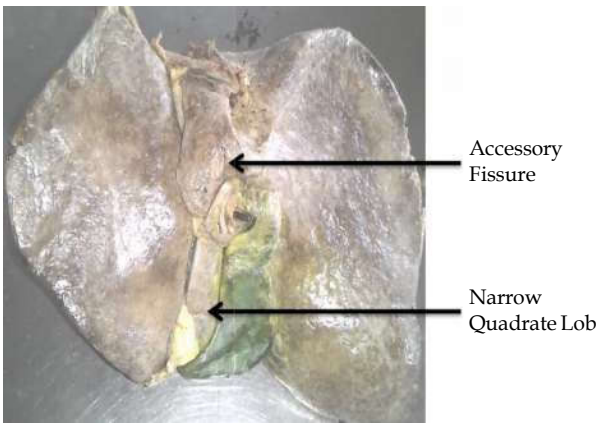
Picture A: Showing accessory fissure in right lobe of liver



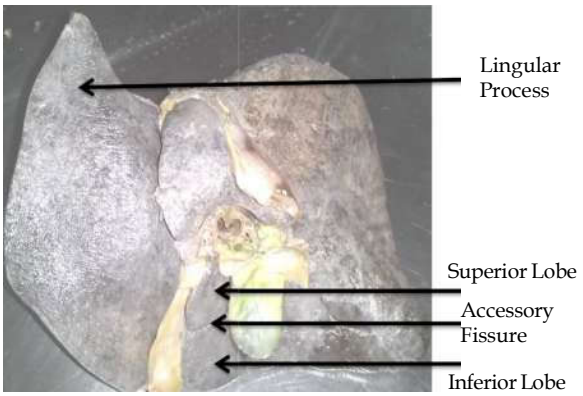
Picture B: Showing accessory fissures in right lobe and hypoplastic left lobe of liver

An accessory fissure dividing quadrate lobe into superior and inferior lobe was observed in 1 (1.25%) specimen (Picture D).

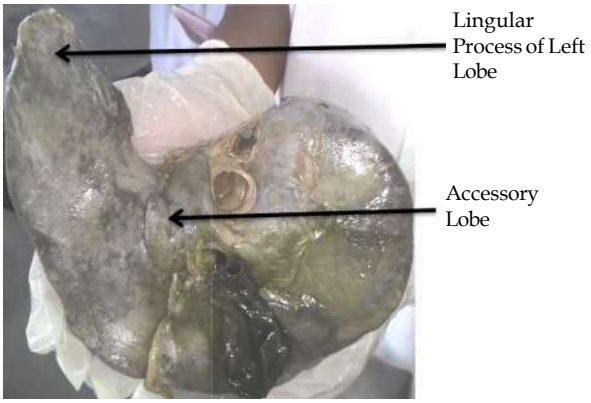
An accessory lobe was observed in connection with the caudate lobe of liver in 1 (1.25%) specimen (Picture E).



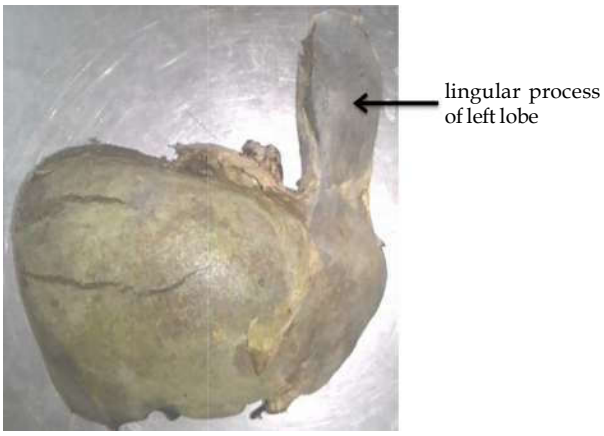
Picture C: Showing an accessory fissure separating caudate process from papillary process and narrow quadrate lobe



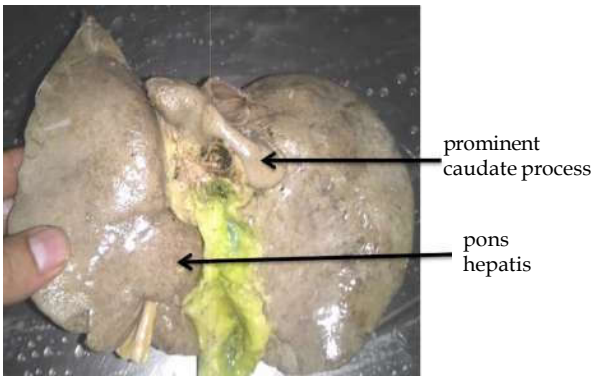
Picture D: Showing an accessory fissure in quadrate lobe dividing it into superior and inferior lobe and lingular process of left lobe of liver



Picture E: Showing accessory lobe connected with caudate lobe of liver and lingular process of left lobe



Picture F: Showing lingular process of left lobe of liver



Picture G: Showing prominent caudate process and pons hepatis

Table 2: Showing Netter's classification of liver variations [3]

	Type of Variation	Present study
Type I	(Very small left lobe, Deep costal impressions)	5%
Type II	(Complete atrophy of left lobe)	------
Type III	(Transverse saddle like liver, relatively large left lobe)	------
Type IV	(Tongue like process of right lobe/Reidel's lobe)	1.25%
Type V	(Very deep renal impression and corset constriction)	------
Type VI	(Diaphragmmatic grooves)	15%

Tongue like lingular process of left lobe was observed in 4 (5%) specimens (Picture D, E, F).

Hypoplastic left lobe was present in 4 (5%) specimens (Picture B).

Abnormal shape caudate process was observed in 1 (1.25%) specimen each (Picture G).

Narrow quadrate lobe was observed in 1 (1.25%) specimen (Picture C).

Pons hepatis which is a segment of hepatic tissue joining quadrate lobe to the left lobe of liver was observed in 1 (1.25%) specimen (Picture G).

In the present study, Type I, Type IV and Type VI variations were observed with Maximum frequency of Type VI variation.

Discussion

Of all the digestive organs, the liver is the one which starts its organogenesis early during 3rd week of intrauterine life and develops most rapidly [4].

The morphological variations in the surface anatomy of the human liver can be classified as congenital or acquired. The congenital anomalies of liver can be divided into anomalies due to defective development and anomalies due to excessive development [5].

Furrowing on the surface of the liver caused by the invaginations of the muscular diaphragm and peritoneum is termed as accessory fissure.

Table 3 : Showing the frequency of the accessory fissures reported by various studies

Name of Authors (Year wise)	Accessory Fissures
Joshi S et.al (2009)[2]	30%
Vinnakota S et.al (2013)[6]	53.44%
Patil S et.al (2014)[7]	10%
Saritha S et.al (2015)[8]	30%
Saxena A et.al (2016)[9]	20%
Chaudhari H et.al (2017)[10]	35%
Shashikantha K et.al (2018)[11]	30%
Present Study	15%

T. Sreekanth [12] observed accessory fissures on the right lobe in 26.66% livers. In the present study, accessory fissures were observed in the right lobe in 12.5% specimens. Sunitha V [6] et al. observed accessory fissure between the caudate process and papillary process in 3.22% specimens. In the present study, similar case was seen in 1.25% specimens. Patil S et al. [7] observed a complete transverse fissure dividing quadrate lobe into superior and inferior lobes in 4% of specimens. In the present study, it was seen in 1.25% specimens. According to Schafer and Symington (1896) and DeBurlet (1910) (as quoted by Macchi et al.), diaphragmatic sulci result from uneven growth of the hepatic parenchyma caused by variable resistance offered by different bundles of the diaphragm muscle. But more recently, radiological and corrosion cast studies have attributed the formation of sulci to the existence of weak zones of hepatic parenchyma, represented by the portal fissures between the adjacent sagittal portal territories. These weak zones offer a lower resistance to external pressure of the diaphragm [2]. According to Auh et al. [13], the accessory hepatic fissures are potential sources of diagnostic errors during imaging. Any collection of fluid in these fissures may be mistaken for a liver cyst, intrahepatic haematoma or liver abscess.

An accessory lobe in connection with the caudate lobe of liver was observed in the present study in 1.25% specimen. The excessive development of liver results in formation of accessory lobe. Accessory liver lobes are composed of normal liver parenchyma in continuity directly with the main mass of liver by mesentery or by a pedicle. A small sized accessory lobe is very important surgically and radiologically as it might be mistaken as lymph node and can be accidentally removed during the surgery or while dissection around the porta hepatis. This might lead to excessive bleeding in abdomen [10].

Vinnakota S et al. [6] observed lingular process of left lobe in 1.72% liver specimens and hypoplastic left lobe in 3.44% specimens we observed lingular process of left lobe and hypoplastic left lobe in 5% specimens each. The lingular process of left lobe may reach up to the spleen and may be mistaken for splenomegaly [14]. In the initial development, the right and left lobes of the liver are equal in size, but due to the development of neighboring organs on the left side, the left lobe regresses. The cause of the reduced size i.e. hypoplastic left lobe in the present study was not known as the neighboring organs were found to be normal in size [15]. Defective development of the left lobe of liver can lead to conditions like gastric volvulus [16].

Prominent caudate process was observed in 9% specimens by Sarala HS et al. [17] whereas in the present study it was observed in 1.25% specimens.

Narrow quadrate lobe was observed in the present study in 1 (1.25%) specimen. A very narrow or absence of quadrate lobe may create confusion in the mind of the radiologist, as the fissure for ligamentum teres in such cases would be very near to the left margin of the gall bladder fossa [18].

Joshi et al. [2] observed the presence of the pons hepatis of variable dimensions, joining the quadrate and the left lobes in 30% cases whereas in the present study, the frequency of pons hepatis was observed in 1.25% specimens. In cases of the pons hepatis bridging the fissure for ligamentum teres, normal visualisation of the fissure would not be possible and dimensions of the right and the left lobes may be mistaken.

Conclusion

In the present study, accessory fissures were observed in 15% specimens, accessory lobes in 1.25% specimens, abnormalities in size and shape of lobes in 13.75% specimens.

As per Netter's classification, maximum frequency of Type - VI variation was reported in the present study. The present study will provide a background knowledge for extensive studies on morphological variations of liver in both cadaveric as well as living subjects.

Strength of the present study

Some of the morphological variants like hypoplastic right lobe, absence of left lobe, abnormal shapes of quadrate lobes which have been described in the literature were not seen in the present study. Every year, as the cadavers are routinely used for dissection of medical undergraduate students in our department, we can further extend this study to find out these variants .

Limitations of the present study

Present study was limited up to adult livers. Pediatric livers were not taken into consideration for the present study. Detailed history of the cadavers in terms of previous diseases which may have impact on liver morphology was not available.

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