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Original Research Article

Morphological and histological variations in livers and its embryological correlation

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ABSTRACT

Aim: To study the variations in gross morphology and any change in histological architecture in cadaveric liver specimens and correlate with development in intrauterine life.
Materials and Methods: The livers were obtained from the cadavers during dissection and museum in the department of Anatomy, MCI recognized private medical college in North India. The morphological and histological observations were documented.
Results: Morphological variations were observed and classified. Histologically all specimens appeared to be normal.
Conclusion: The knowledge of such variations is important to anatomists, morphologists and embryologists for developmental anomalies. This will be beneficial for the surgeons for planning surgery involving liver and radiologists for interpretation of CT scans and MRI images.

1. Introduction

The liver is wedged-shaped, largest of the abdominal viscera, occupying most of the right hypochondrium and epigastrium, and frequently extends into the left hypochondrium as far as the left lateral line. As the body grows from infancy to adulthood, the liver rapidly increases in size. The size of the liver also varies according to sex, age and body size. The capsule is no longer thought to play an important part in maintaining the integrity of the shape of the liver.[1]

The liver is responsible for a wide range of metabolic activities including homeostasis, nutrition, immune defences, blood detoxification and purification, synthesis of plasma proteins, production of bile and the metabolism of carbohydrates, fats and proteins. In man, the liver is essential for survival since there is no artificial organ or equipment to compensate for the absence of liver function.[1] It is an important site of haemopoiesis in the fetus.[1]

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The complexity of liver function and its importance in body homeostasis has encouraged many anatomists to study the morphological features of the organ in considerable details. Despite recent technological advances in the evaluation of liver parenchyma using imaging techniques, such as computed tomography or nuclear magnetic resonance,[2] detailed studies of the macroscopic anatomy of cadaveric livers can still contribute to the identification of important anatomical variations. In many cases, such variations have enabled researches to understand specific responses to therapies applied in the treatment of liver disease.

The major fissures are the important landmarks for interpreting the lobar anatomy and locating the liver lesions. In the era of imaging and minimally invasive approaches, it is very important on the part of both the radiologists and operating surgeons to have a thorough knowledge of the anatomy and the commonly occurring variations of this organ. Anatomists witness most of the variations of the lobes and fissures of the liver. Although the segmental anatomy of the liver has been extensively researched, there

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are very few studies regarding the surface variations of the liver.

The aim of the present study was to investigate the type and frequency of anatomical variations and to find out any histological changes and correlate these with intrauterine development, in a collection of cadaveric livers.

2. Materials and Methods

Thirty nine (39) livers from adult human cadavers, fixed in 10% buffered formalin solution available in the department of Anatomy, MCI recognized private medical college in North India were studied. Age and gender of these specimens were not known. The specimens looked apparently normal. Histological sections from cornu and lingular process (if present) and different areas from the lobes in other specimens were taken and processed by H and E staining. These were observed for any variations in archi tecture and cellular structure.

3. Observations and Results

3.1. Morphological observations

Livers were examined on different occasions by two observers. The results obtained were compared and ratified. The distinct morphological characteristics observed were recorded on data sheets. On the basis of these descriptions, the organs were classified into ten groups (Table 1). The lingular process of left lobe (Type 8) was further defined according to shape (Table 2).

Table 1 shows different variants of liver. Type 1 is defined as the morphologically normal liver as classically described in the standard textbooks.[1,3], The present study showed an incidence of 28 specimens of type 1 (71.79%; Figure 1).

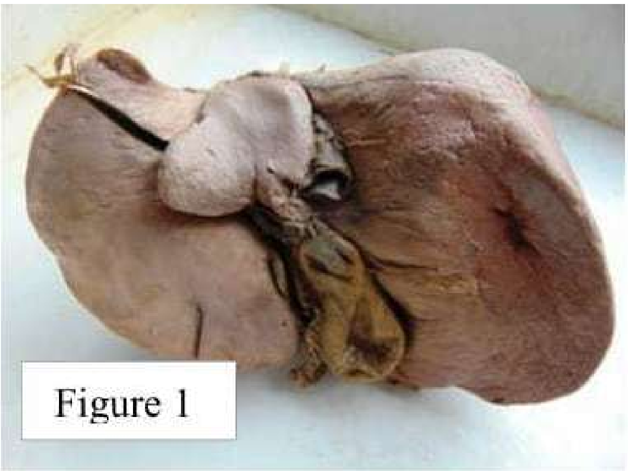

Fig. 1: Normal liver

Type 2 is liver with very small left lobe with incidence of 1 specimen (2.56%, Figure 2).

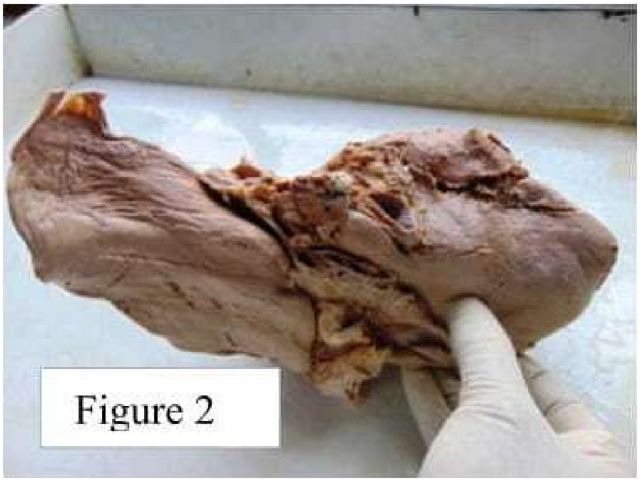

Fig. 2: Very small left lobe

Type 3 is defined as transverse “saddle-like” liver (1 specimen; 2.56%) as seen in Figure 3.

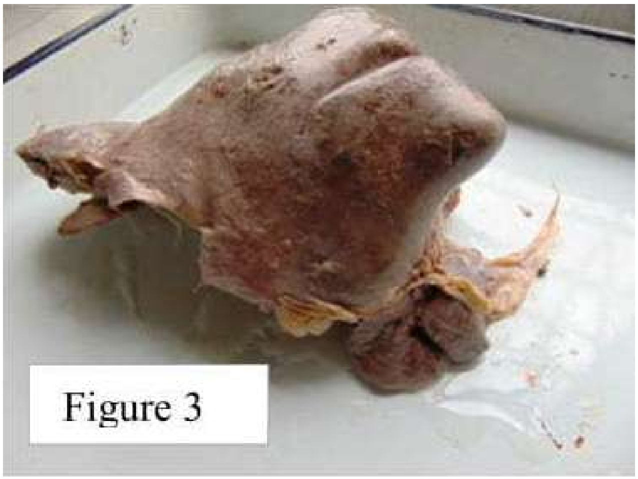

Fig. 3: Saddle-like liver

Types 4 (Figure 4), 5 (Figure 5) and 6 (Figure 6) are defined as livers with very deep renal impression, very deep costal impressions and diaphragmatic grooves respectively with incidence of 1 specimen each (2.56%).

Type 7 is defined as liver with enlarged left lobe (Figure 7). It was seen in 1 specimen (2.56%).

Type 8 is defined as liver with lingular process of left lobe (3 specimens; 7.69%). Lingular process is defined as tongue-like projection from the margin of liver.

Type 9 and 10 are defined as bicornuate (1 specimen; 2.56%, Figure 11) and unicornuate (1 specimen; 2.56%, Figure 12) left lobes of liver respectively. Cornu is defined as quadrilateral process projecting from the margin of the

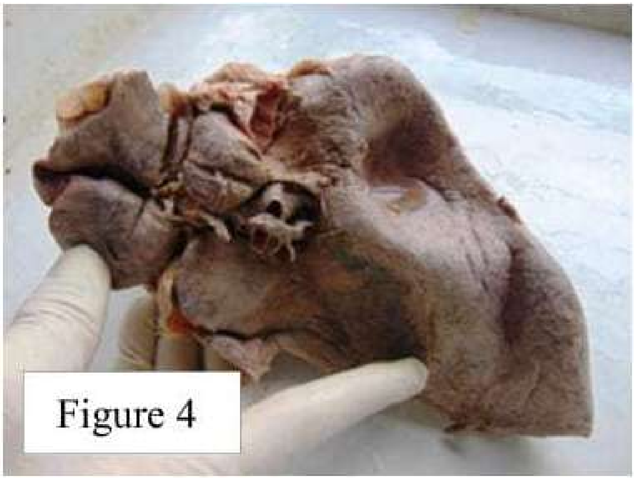

Fig. 4: Very deep renal impressions

Fig. 5: Very deep costal impressions

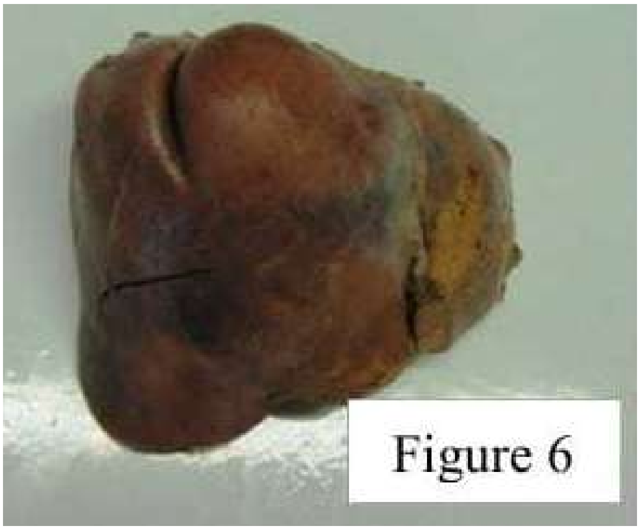

Fig. 6: Diaphragmatic grooves

liver.

Table 2 shows different shapes of lingular process of left lobe. They have been categorized into three types: apical (1 specimen, 2.56%; Figure 8), conical (1 specimen; 2.56%, Figure 9) and rounded (1 specimen; 2.56%, Figure 10).

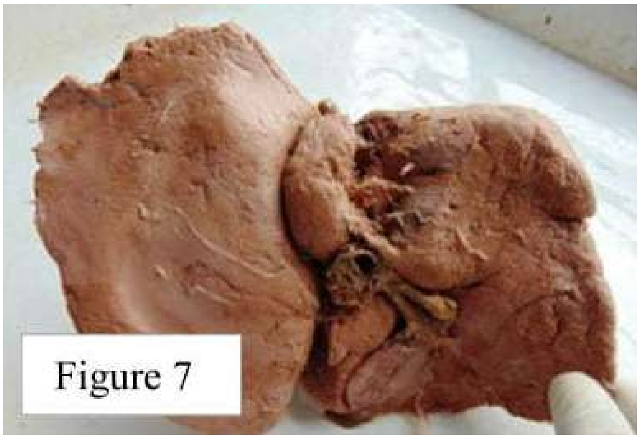

Fig. 7: Enlarged left lobe

Fig. 8: Apical lingular process of left lobe

3.2. *Histological observations*

Sections for histological examination were taken from the cornu, lingula and different sites of the left and right lobes of all 39 specimens. All the histological sections taken from the liver specimens showed normal architecture. There was no change in cellular arrangement of cords and sinusoids were normal (Figures 13, 14, 15 and 16).

4. Discussion

Embryologically, the liver primodium appears in the middle of the 3^{rd} week as an outgrowth of the endodermal epithelium at the distal end of the foregut. This outgrowth,

Table 1: Different types of livers

Organ types	Characteristic features	Number	Frequency	Figure number
Type 1	Normal liver	28	71.79	1
Type 2	Very small left lobe	1	2.56	2
Type 3	Transverse "saddle-like" liver	1	2.56	3
Type 4	Very deep renal impression	1	2.56	4
Type 5	Very deep costal impressions	1	2.56	5
Type 6	Diaphragmatic grooves	1	2.56	6
Type 7	Enlarged left lobe	1	2.56	7
Type 8	Lingular process of left lobe	3	7.69	8 – 10
Type 9	Bicornuate left lobe	1	2.56	11
Type 10	Unicornuate left lobe	1	2.56	12

Table 2: Different types of lingular process of the left lobe

Type	Number	Frequency (%)	Figure number
Apical	1	2.56	8
Conical	1	2.56	9
Round	1	2.56	10

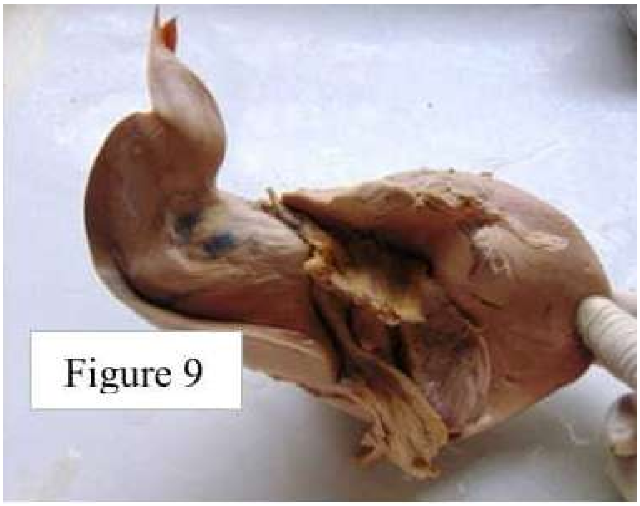

Fig. 9: Conical lingular process of left lobe

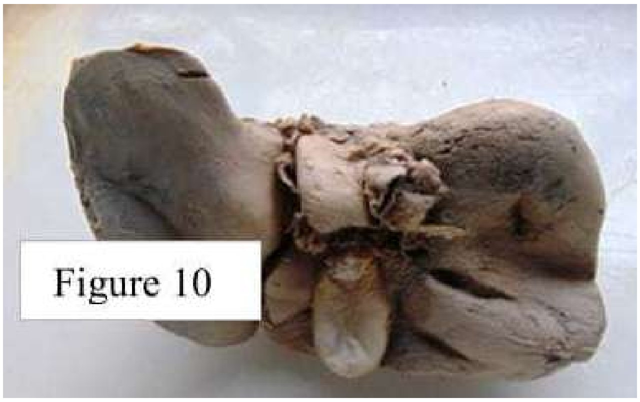

Fig. 10: Round lingular process of left lobe

Fig. 11: Bicornuate left lobe

Fig. 12: Unicornuate left lobe

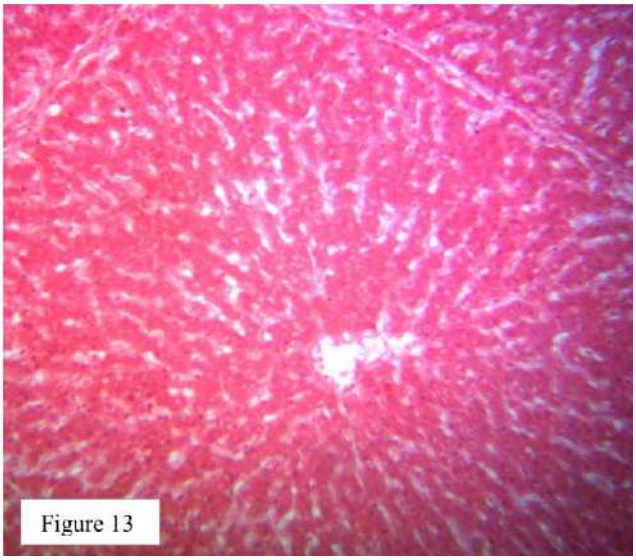

Fig. 13: Lingular process of left lobe of liver

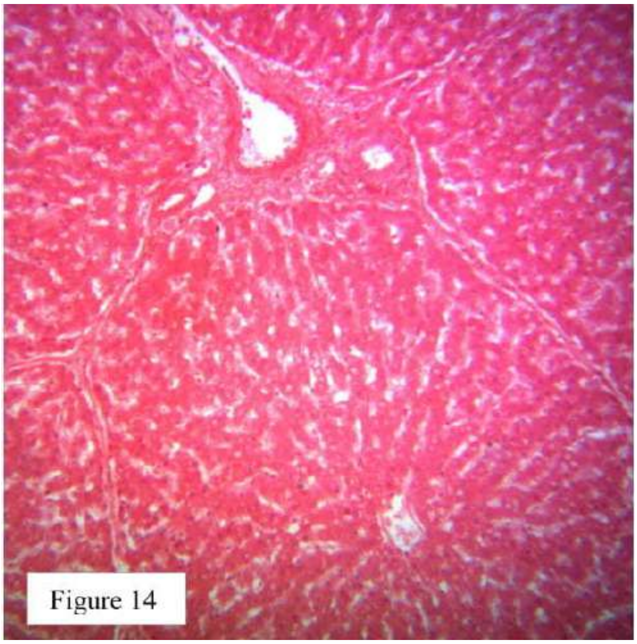

Fig. 14: Cornu of the left lobe of liver

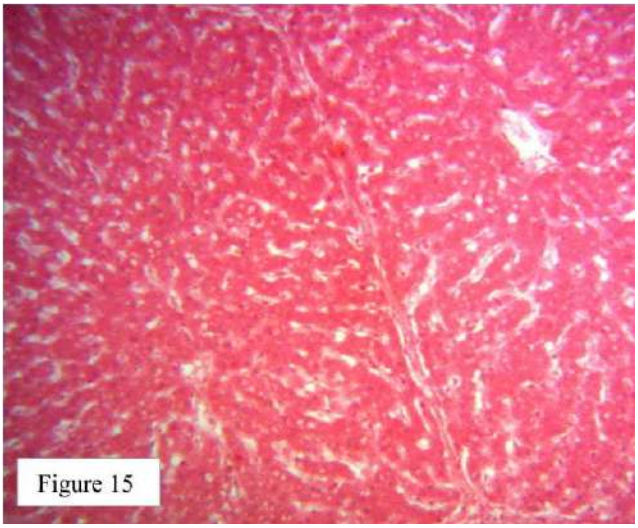

Fig. 15: Left lobe of liver

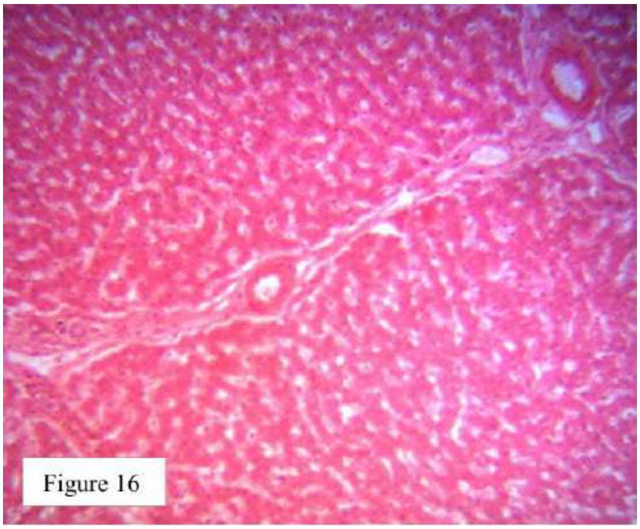

Fig. 16: Right lobe of liver

the hepatic diverticulum or liver bud, consists of rapidly profilerating cells that penetrate the septum transversum.[4]

The liver is reddish brown in colour, although this can vary depending upon the fat content. Obesity is the most common cause of excess fat in the liver (also known as steatosis): the liver assumes a more yellowish tinge as its fat content increases. The texture is usually soft to firm, depending upon the volume of blood and the fat content.[1]

The variations observed in the anatomy of the human liver have been classified as congenital or acquired. Congenital anomalies can be attributed to the following factors: a) separate lobes (considered to be a congenital variation by some anatomists); b) atrophy at some locations in the parenchyma; c) presence of only one lobe; d) presence of multiple lobes, typically involving numerous divisions (up to 16) of the right lobe; e) small lobes; f) peduncular lobes; g) lobes without division; and h) accessory lobes. Acquired changes in liver morphology are represented by the following characteristic features: i) linguiform lobes, ii) costal organ with very small left lobe, iii) deep renal impressions.[5]

Out of the 39 livers studied, 28 specimens (71.79%) were found to be normal. Morphological variations were observed in 11 specimens (28.20%).

On the basis of these variations, the livers were classified into ten groups. Six of these specimens, types 1 to

6, correspond to the morphological types (including the normal type) established by Netter[3] as described in Table 1. The remaining four liver specimens, types 7 to 10 reported inTable 1 of the present study have not been adequately described according to the classification of Netter[3] and were considered as new variant types 7, 8, 9 and 10.

Type 6 showed diaphragmatic grooves (Figure 6). This type of variant has been described previously by Nagato AC et al[2] and Yoshimitsu K et al.[6] These authors considered the diaphragmatic grooves to be accessory hepatic fissures caused by invaginations of the diaphragm. This can also be due to peritoneal fold or non union of segments in foetal life.

Type 7 showed enlarged left lobe (Figure 7). Historically, the liver has been considered to be divided into four lobes by the surface peritoneal and ligamentous attachments. The left lobe is the smaller of the two main lobes, although it is nearly as large as the right lobe in young children. It lies to the left of the falciform ligament with no subdivisions and is substantially thinner than the right lobe.[1] According to Gray and Williams,[7] the right lobe is typically larger and more bulky than the left. On this basis, one liver (2.56%) described as type 7 is considered as a morphological variation because the left lobe was very much larger than the right. Bezerra ASA et al[8] suggested that the reduction in size of the right hepatic lobe and the compensatory increase of the left and caudate lobes may result from pathological processes in patients with schistosomiasis.

Types 8, 9 and 10 of liver specimens with lingular processes and cornu of the left lobe may be due to excessive tissue formed at a localized site in the form of extentions or pressure from the surroundings organs during fetal life causing inhibition of formation of complete left lobe so these processes developed in the area of least resistance.

Histologically, all the specimens were normal according to the description in standard textbooks of histology.[9]

Though distinct morphological types of human liver can be identified in the literature, relatively few studies are available on this topic and detailed descriptions of the different types of anatomical variations are scarce. One reason for this may be associated with a particular difficulty encountered in the present study relating to the characterisation of cadaveric sources in terms of sex, age and previous diseases, all of which may impact on liver morphology.

Some apparent morphological changes detected during advanced imaging examinations may actually be pseudo–lesions resulting from perfusion defects, focal fatty infiltrations and other causes, and may not represent true parenchymatous lesions.[2]

This data suggests that there is a high incidence of anatomical variations in the human liver. No statistical data relating to the frequency of occurrence of livers displaying gross variations in morphological character could be found in the literature in order to serve as a basis for comparison with the studied samples.

5. Conclusion

Though many anatomical variations in the shape of the liver were encountered, histologically all specimens were normal hence the present study suggests that functionally these livers were normal. The possible explanation for gross anomalies could lie in its embryological development. Detailed descriptions of normal and variant liver morphologies can make a significant contribution to understanding the causes of the changes and is a prerequisite for the favourable outcome of a surgical procedure. It is useful for the imaging specialists and surgeons to avoid misinterpretation and misdiagnosis for appropriate planning of the surgical procedures.

6. Source of Funding

None.

7. Conflict of Interest

None.

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