Original Article

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Variations in the Morphology of Human Liver and Its Clinical Importance

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Abstract

Introduction: Liver is the large abdominal viscera occupying a substantial portion of the abdominal cavity. Size of the liver varies according to age, sex, & body size. The gross anatomical appearance of liver is divided into right, left, caudate & quadrate lobes by the surface, peritoneal & ligamentous attachments. The most widely accepted classification of liver is done by Couinaud (1957) & Healy & Schroy (1953) who divided liver into eight functional segments. A sound knowledge of normal & variant liver anatomy is a prerequisite to have a favorable surgical outcome. In the era of imaging & minimally invasive approaches, it is imperative to have a thorough knowledge of anatomy & normally occurring variations of this organ. *Material & Methods*: In the present study, we studied 50 embalmed human livers removed from adult human cadavers. Various shapes of right, left, caudate & quadrate lobes were observed. The presence of accessory fissures, lobes, pons hepatis & any other variation were noted. We also studied variations of liver according to Netter's classification. *Results and Discussion:* Out of the 50 specimens, 23 livers (46%) were normal i.e.without any accessory fissures and accessory lobes. Remaining 27 livers (54%) showed presence of accessory fissures and accessory lobes. Accessory fissures are most commonly observed on the inferior surface of right lobe & on the quadrate lobe. With advances in liver surgery like laparoscopic hepatectomy and laparoscopic thermal ablation for patients with hepatic tumor, these variations assume more importance. *Conclusion:* The findings of our study may be helpful to the radiologists & surgeons to avoid possible errors in the diagnosis and to assist in planning appropriate surgical approach.

Keywords: Liver; Caudate Lobe; Quadrate Lobe; Segment; Accessory Fissures; Pons Hepatis.

Introduction

Liver is the large abdominal viscera occupying a substantial portion of abdominal cavity. It occupies most of the right hypochondrium & epigastrium and frequently extends into the left hypochondrium as far as left lateral line. Size of the liver varies according to age, sex, & body size. The size increases from infancy to adulthood, reaches a plateau around 18 yrs & is followed by gradual decrease from middle age [1]. It has an overall wedge shape; the narrow edge of the wedge is directed towards left hypochondrium.

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Historically, the gross anatomical appearance of liver is divided into right, left, caudate & quadrate lobes by the surface peritoneal & ligamentous attachments. The most widely accepted classification of liver is done by Couinaud (1957) & Healy & Schroy (1953) who divided liver into eight functional segments. This classification is also accepted by Federative committee on anatomical terminology [1, 2].

A sound knowledge of normal & variant liver anatomy is a prerequisite to have a favorable surgical outcome. Netter classified the variations of liver into six types [3]. The major fissures are important landmarks for interpreting the lobar anatomy and locating the liver lesions. In the era of imaging & minimally invasive approaches, it is imperative on the part of the radiologists and operating surgeons to have a thorough knowledge of anatomy & normally occurring variations of this organ. Although segmental anatomy of liver has been extensively researched, a very few studies have dealt with surface variations of liver [4]. the aim of our study is to

determine gross anatomical variations of liver & their clinical & surgical variations.

Material and Methods

The study was conducted on 50 embalmed human Livers in the department of Anatomy, Government medical college, Nagpur. The liver specimens were removed from adult human cadavers during routine dissection of medical undergraduate students & then fixed in 10% formalin. The livers were apparently normal & free from any disease. Various shapes of right, left, caudate and quadrate lobes as well as the presence of other variations on the surface of the liver were noted.

Observations & Results

Out of the 50 specimens, 23 livers (46%) were normal i.e.without any accessory fissures and accessory lobes (Figure 1). Remaining 27 livers (54%) showed presence of accessory fissures and accessory lobes (Table 1). Accessory fissures are most commonly observed on the inferior surface of right lobe & on the quadrate lobe.

In 3 specimens, quadrate lobe showed a transverse fissure which divided it into superior & inferior quadrate lobes (Figure 2), while in 2 specimens quadrate lobe showed a vertical fissure.

Fig. 1: Inferior surface of liver without accessory fissure. Caudate and quadrate lobes are quadrangular

Fig. 2: Showing accessory fissure on quadrate lobe dividing it into superior and inferior quadrate lobes. Accessory fissures also present on caudate and left lobes.

Fig. 3: Inferior surface of liver showing pons hepatis (PH) joining quadrate lobe with left lobe & caudate lobe showing caudate process(CP) joining to right lobe

On the right lobe , fissure running from right margin of fossa for gall bladder into the inferior surface was most commonly observed .

Presence of pons hepatis of variable dimensions joining the quadrate and the left lobes was present in 12% cases. In the majority of cases, the pons was bridging the upper third of fissure for ligamentum teres (Figure 3). In one case, the pons was present in the depth of this fissure (Table 1).

Various shapes of caudate and quadrate lobes were encountered. In case of caudate lobe, most common shape is rectangular in 56%, then bicornuate in 20% and had different shapes (pear shaped, triangular, quadrangular, inverted pear shaped) in remaining 24%. Prominent caudate process was observed in 30% cases (Figure 3).

Table 1: Different morphological variations of Liver

Morphological Features	Number of specimens
Normal (i.e.without any accessory fissures and accessory lobes)	23
Accessory Fissures	27
Pons Hepatis	6
Superior & inferior quadrate lobe	3

In case of quadrate lobe, the shape was rectangular in 64%. In 6% cases, quadrate lobe is very narrow (Figure 4). In remaining cases, different shapes (pear shaped, triangular with apex up, presence of tongue

Table 2: Classification of variations of liver according to Netter

Types	Number of Specimens
Type 1 (very small left lobe)	1
Type 2 (complete atrophy of left lobe)	Nil
Type 3 (Transverse saddle like liver, relatively large left lobe)	6
Type 4 (Tongue like process of right lobe)	3
Type 5 (very deep renal impression)	2
Type 6 (Diaphragmatic grooves)	3

Fig. 4: Liver showing elongated & narrow caudate & quadrate lobes.

Fig. 5 (A): Liver showing abnormal shape, almost disc-like, flattened from above downwards, from anterior aspect

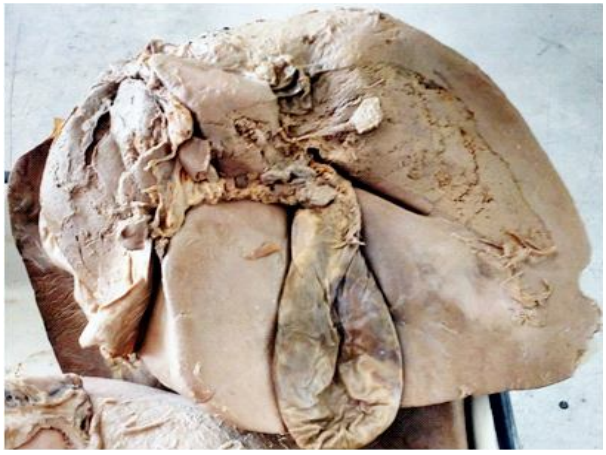

Fig. 5 (B): Disc like liver showing inferior aspect, left lobe even smaller than quadrate lobe

Fig. 6: Liver showing very small left lobe, Netter's type 1

Fig. 7: Liver showing transverse saddle like liver, relatively large left lobe(Netter's type 3 liver)

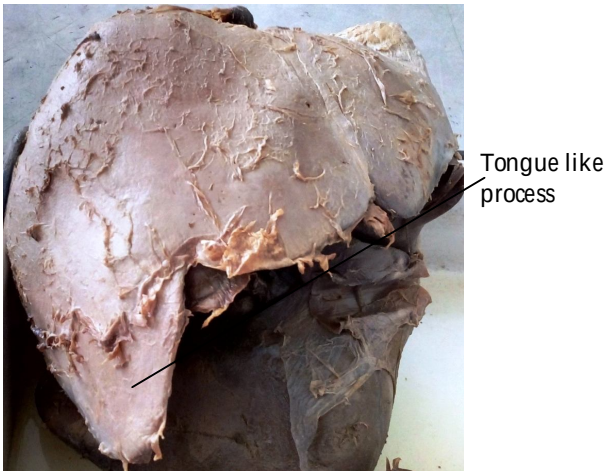

Fig. 8: Liver showing tongue like process of right lobe (Netter's type 4**)**

Fig. 9: Liver showing very deep renal impression (Netter's type 5)

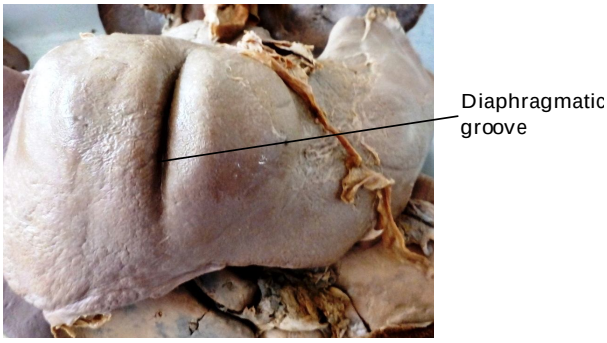

Fig. 10: Liver showing diaphragmatic grooves (Netter's type 6)

like process) were observed. In one specimen, very abnormal shape of liver is encountered. Liver appears almost disc-like. Its left lobe appears to be very small, even smaller than quadrate lobe (Figure 5 A & B).

The liver specimens were also classified according to six types of liver variations (Figure 6 to 10) as described by Netter [3].

Discussion

In the present study, 27(54%) livers showed accessory fissures, which resulted in the formation of accessory lobes. According to Auh et al, the accessory hepatic fissures are potential sources of diagnostic errors during imaging. Any collection of fluid in these fissures may be mistaken as a liver cyst, intrahepatic hematoma or liver abscess [5]. Mazziotti et al advocated the use of intraoperative utrasonography in liver surgery to determine the anatomical location and the extent of lesion, thereby minimizing unnecessary tissue dissections and traumatic surgical maneuvers [6].

Accessory fissures most commonly noted here were in the inferior surface of right lobe and then in the quadrate lobe. Mini accessory lobes reported here are surgically and radiologically very important due to its small size. It might be mistaken for a lymph node. It might be accidently removed during the surgeries in and around the porta hepatis. Torsion of the accessory lobe is a surgical emergency and it has to be attended early [7]. An accessory lobe could be formed by the displacement of the primitive rudiment of the organ or by persistence of the mesodermal septa during its proliferation[8].

The diaphragmatic sulci seen on the anterosuperior surface were present in 6% of the livers which 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 sagital portal territories. A higher incidence of such grooves was observed by Macchi et al [9] and Auh et al [5] and lower incidence observed by Sachin Patil et al [10].

The different morphology of all the lobes was noted. Variations of liver were classified according to Netter. The similar study was conducted by Sachin Patil et al in 2014 . Pons hepatis bridging the fissures for ligamentum teres was an important finding of this study, which was previously reported by Joshi et al and Sachin Patil et al. In cases of pons hepatis , normal visualization of the fissure would not be possible and dimensions of the right and left lobes may be mistaken [4].

Conclusion

With advances in liver surgery like laparoscopic hepatectomy and laparoscopic thermal ablation for patients with hepatic tumor, these variations assume more importance. In conclusion, this study highlights the frequent occurrence of morphological variations on the liver surface. The findings of our study may be helpful for surgeons and radiologist to avoid possible errors in interpretations and subsequent misdiagnosis and to assist in planning appropriate surgical approaches.

Conflicts of Interest

None

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Ethical Clearance: Obtained

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