ORIGINAL RESEARCH

Surface morphology of the Right lobe of the Human Liver

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Abstract

Background and objective: The liver, being the largest organ in the body exhibits various gross morphological characteristics that are valuable and important in diagnostic and interventional radiology as well as in gastroenterological and surgical procedures. This descriptive observational study documents the surface morphological variations of the right lobe of the human liver.

Methods: 10% formalin-fixed liver specimens used for undergraduate anatomy teaching at the Department of Anatomy, Faculty of Medicine, University of Peradeniya were studied for the surface morphology of the right lobe for shape, diaphragmatic grooves, accessory fissures, and lobes.

Results: Twenty specimens from donors above 65 years of age with a female majority (60%) were studied. Morphologically normal right lobes were seen in 11 (55%). Others showed several variations. Accessory fissures were seen in 4 (20%) cases. Accessory lobes were found in 2 (10%) with Ridel's lobe in 1 (5%) case. Diaphragmatic grooves and costal grooves were reported in 1 (5%) each. Saddle-shaped liver was present in two (10%) cases while 2 (10%) had a hump/ conical-shaped right lobe. A large right lobe was seen in one (5%) specimen.

Conclusion: Variations in the shape of the liver and surface morphology of the right lobe are frequent. Knowledge regarding these variations will prevent misdiagnosis of lesions and normal anatomy as well as prevent iatrogenic injuries during procedures of the organ and the surrounding area.

Keywords: Ridel's lobe, Accessory fissure, Accessory lobe, Diaphragmatic groove, Saddle-shaped liver

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Introduction

The liver is the largest gland in the body and the second largest organ after the skin (1,2). An average adult liver weighs approximately 1500 g and receives 1500 ml of blood per minute. It is usually a wedge-shaped structure lying underneath the diaphragm and occupies most of the right hypochondrium and epigastrium and extends into the left hypochondrium as well (1,3).

The liver has two main surfaces: diaphragmatic and visceral. While the diaphragmatic surface is in contact with the undersurface of the diaphragm, the visceral surface is in contact with the intestines and other organs of the abdomen. The diaphragmatic surface is convex and nicely fits into the right dome of the diaphragm. It can be subdivided into anterior, posterior, superior, and right surfaces, which do not have clear demarcations and blend with one another (1). Hepatic arteries, portal vein branches and bile ducts enter the liver on the visceral surface at the porta hepatis. The gall bladder lies in its own fossa on the visceral surface as well (4).

From the two surfaces, peritoneal folds run to the diaphragm and stomach, respectively. These peritoneal folds form several ligaments. On the anterior surface, there is the falciform ligament, which divides the liver into gross right and left lobes. On the visceral surface, there are two much smaller lobes, superiorly caudate and below it the quadrate. They are separated from the right lobe by the inferior vena cava and from the left lobe by the ligamentum venosum and ligamentum teres. The porta hepatis separates the caudate from the quadrate lobe in the middle (5).

This normal morphology of the liver can vary from individual to individual. These variations are encountered during surgical interventions and radiological imaging procedures, including ultrasound as a major landmark in interpreting liver images and locating lesions (3,6).

Knowledge of the normal anatomical structure of the liver, size, shape, and presence of fissures and ligaments is a requirement for interpretation of diagnostic imaging and planning and performing surgery. Knowing possible variations in surface morphology will also prevent possible misinterpretations of images and unnecessary surgical complications.

Methods

This descriptive observational study was conducted at the Department of Anatomy, Faculty of Medicine, University of Peradeniya. Twenty liver specimens of both sexes were removed from 10% formalin-fixed cadavers that were used for undergraduate anatomy teaching. The surface morphology of the right lobe of the liver was studied for shape, diaphragmatic grooves, accessory fissures, and lobes.

Figure 1: Normal liver (wedge-shaped)

Figure 2: Diaphragmatic grooves

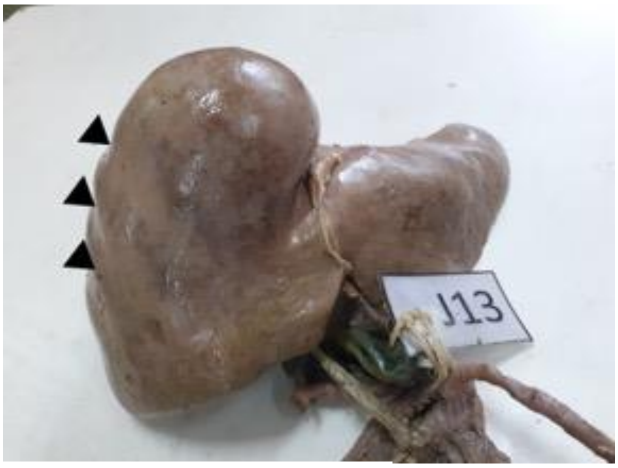

Figure 3: Costal grooves

Table 1: Gross morphological variations in the right lobe of the liver in the present study

Variation	Number of specimens (%)
Diaphragmatic grooves	1 (5%)
Costal grooves	1 (5%)
Accessory fissures	4 (20%)
Accessory lobes	2 (10%)
Ridel’s lobe	1 (5%)

Figure 4: Accessory fissures

Figure 5: Accessory lobes

Figure 6: Ridel's lobe

Table 2: Shapes of the liver in the present study

Shape	Number of specimens (%)
Wedge	15 (75%)
Saddle	2 (10%)
Hump/ conical in right lobe	2 (10%)
Large right lobe	1 (5%)

Figure 7: Saddle-shaped liver

Figure 8: Hump/ Conical-shaped right lobe

Figure 9: Comparatively large right lobe

Table 3: Comparison of morphological variations of the present study with findings of other authors

Variation	Present study (n=20)	Shweta et al (n=160)	Saritha et al (n=50)	Chin et al (n=33)	Srivastava et al (n=39)	Chaudhari et al (n=80)	Singh & Rabi (n=70)
Accessory fissures	4 (20%)	18 (11.25%)	8 (16%)	3 (9.09%)		10 (12.5%)	36 (51.43%)
Accessory lobes	2 (10%)	1 (0.625%)	1 (2%)				
Ridel’s lobe	1 (5%)		8 (16%)	6 (18.18%)		1 (1.25%)	
Diaphragmatic grooves	1 (5%)		2 (4%)	4 (12.12%)	1 (2.56%)	6 (7.5%)	12 (15.72%)
Costal grooves	1 (5%)		2 (4%)		1(2.56%)	14 (17.5%)	
Shape of the liver/ right lobe							
Wedge	15 (75%)						
Saddle	2 (10%)		2 (4%)		1(2.56%)		
Hump/ conical in right lobe	2 (10%)						13 (18.57%)
Large right lobe	1 (5%)						

Results

The specimens consisted of 12 (60%) female and 8 (40%) male livers from donors above 65 years of age.

Right lobes of 11 (55%) livers were morphologically normal (Figure 1). The remaining 9 (45%) right lobes showed several morphological variations (Table 1). Some of the livers showed multiple variations. Diaphragmatic grooves (Figure 2) were present in 1 (5%) specimen, while shallow costal grooves were observed in another one (5%) (Figure 3). Accessory fissures (Figure 4) of varying sizes were found in 4 (20%) specimens. Accessory lobes (Figure 5) were detected in 2 (10%) specimens and specific Ridel's lobe (Figure 6) was present in 1 (5%) case.

The shape of the right lobe was also identified and categorised (Table 2). Of all 20 specimens, 15 (75%) had normal wedge-shaped (Figure 1). Two (10%) cases showed saddle-shaped liver (Figure 7), while 2 (10%) had a hump/ conical-shaped right lobe (Figure 8). A comparatively large right lobe was seen in one (5%) specimen (Figure 9).

Discussion

The surface gross morphological variations of the liver are rare and can be congenital or acquired (2, 3, 5, 6, 7, 8). These variations can range from, irregularities in the form, one or more accessory lobes or fissures, presence of cysts, atrophy or complete absence of one of the lobes (agenesis) or hypoplasia, undue size of a particular lobe, lobes separated by glands, small lobes, peduncular lobes, lobes without division to multiple lobes. All of the above are considered to be congenital variations. Acquired variations may include changes induced by closely related organs, linguiform lobes, and deep renal impressions (2,4-7).

Most of these variations are found accidentally during physical examination, while performing an autopsy, or during imaging interpretation done for either liver or diseases of other visceral abdominal organs (8). However, there can be doubtful situations where the normal gross morphology is distorted due to these anomalies.

Congenital variations are mainly due to defective or excessive development of the parts of the liver, diaphragm, or suspensory apparatus of the liver but are rare (4,8). The hepatic diverticulum appears in the middle of the 3rd week from the endodermal epithelium as an outgrowth at the end of the foregut (3,9). With the development and enlargement of the organ, it expands caudally into the abdominal cavity. The ligaments are extended from the developing liver and are also formed by obliteration of fetal structures at/ after birth. Liver growth is tightly controlled by liver-specific genes in the foregut endoderm, their inhibitory factors, and factors that inhibit these inhibitory factors (9). Varying responses to these factors and genes, persistence of mesodermal septations, displacement of primitive parts of the organ, and peritoneal infoldings may cause congenital variations in the liver morphology (4,10).

Acquired variations are due to insults to the liver during the lifetime of a person. Excessive pressure/ pull by the diaphragm or peritoneal ligaments, due to other related/ adjacent abdominal organs, and diseases causing atrophy/ hyperplasia/ hypertrophy of the liver are some of these insults (10).

The right lobe of the liver is usually larger than the left lobe giving the classical wedge shape to the organ. 75% of specimens in the present study had this usual shape. We found a comparatively very large right lobe in one specimen (5%). There were two cases (10%) with saddle-shaped livers and this finding is similar to the reported literature (2, 3). Humps or conical-shaped right lobe was seen in two cases (10%) in our study. Singh and Rabi reported 13 (18.57%) right lobes of this shape in their study out of 70 specimens (10).

Fissures and accessory lobes (with Ridel's lobe) are the commonest variations seen in the right lobe (10), and the fissures in the present study result in the formation of accessory lobes. Fissures in the right lobe were described more frequently in literature. Singh and Rabi reported an incidence of 51.43%, while Sangeetha et al. observed a 20% incidence, and Shweta et al. an 11.25% incidence (6,10,11). The present study has a 20% incidence (4 cases). Loculated fluid collections (ascites, infected ascites, hemoperitoneum) in these fissures can be potentially misdiagnosed as cysts, liver abscesses, or intrahepatic hematomas. Accessory hepatic fissures on the superior surface of the liver usually fill with subdiaphragmatic fat and peritoneum, thus in the presence of ascites, fluid can get into the fissure and be seen as multiple thin lines that are projected towards the liver parenchyma in sectional radiology (4,10). Chronic fluid collections in the fissure for ligamentum teres are more or less round in computed tomography (CT) with a target sign with ligamentum teres at the center. However, a parasagittal ultrasound may not be able to separately demonstrate the difference between the ligamentum teres and a complicated fluid collection. Similarly, a large cyst in the caudate lobe might mimic a fluid collection in the fissure for ligamentum venosum and vice versa (12). Multiple fissures can mimic macronodular liver in CT (10). There is a risk of peritoneal seeding of tumour cells (e.g. from ovarian cancer) into the fissures and these may mimic intrahepatic lesions in radiological studies (low-attenuated focal lesions in CT) (4, 10,12).

The present study has a 10% (2 cases) incidence of accessory lobes on the diaphragmatic surface of the right lobe and one case of Ridel's lobe. Shweta et al. and Saritha et al. reported the presence of accessory lobes in the right lobe in 1 (0.625%) and 1 (2%) cases, respectively, while other studies mostly found accessory lobes in caudate and quadrate lobes (4, 6, 10). Many authors have reported the presence of Ridel's lobe in their studies (2, 4,6,8,13), and all reported a higher incidence than in this study, except Chaudhari et al., who also reported one case. According to Phad et al., the presence of Ridel's lobe may be mistaken for an unidentified abdominal mass in non-contrast radiological studies of the abdomen (13). Although accessory lobes are commonly found on the visceral surface of the liver, these can be found on the gallbladder surface which can interfere with gallbladder surgeries (4). Small accessory lobes may be radiologically misdiagnosed as lymph node or can be accidentally removed during lymph node resection around porta hepatis (4, 10).

Diaphragmatic grooves also are a common finding reported by many authors previously (2,3,4,6,8,10). and the present study had one (5%) case. Right lobe costal grooves/ impressions were described by several other authors with similar or higher incidences (2, 3, 4). Left lobe costal impressions were described by Singh and Rabi but not on the right lobe (10). As these grooves have an intact visceral peritoneum, surrounding accumulated fluid or deposited peritoneal metastasis in these areas can easily be confused with hypoattenuating, peripheral focal lesions of the liver (12).

During radiological imaging studies, variations such as accessory fissures and lobes can be mistaken for pathological liver lesions or enlarged periportal lymph nodes, particularly small ones. Therefore, these small accessory lobes can be injured or lead to excessive bleeding during surgeries if not expected. The findings of the present study are compared with the findings of various authors in Table 3.

Limitations and future directions

This study focuses mainly on the surface gross morphology of the right lobe of the liver but can be extended with a larger number of study samples into a broader study with a description of the surface morphology of all lobes. Further gender-based analysis may also be useful.

Conclusion

Surface morphological variations of the right lobe of the liver are frequent. It is important for surgeons and radiologists to identify these variations when planning and performing interventional procedures. A thorough knowledge will prevent misdiagnosis and iatrogenic injuries. Documenting liver morphology will broaden the scope for anatomists as well as radiologists and surgeons.

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Ethical approval

Ethical Review Committee, Faculty of Medicine, University of Peradeniya (2022/EC/59).

Conflict of interest

None

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Author contributions

MJSJ – Retrieval of liver specimens, Photography and identification of surface morphology/ variations, Drafting of the main manuscript, Review and approval of the final version. **HA** - Identification of surface morphology/ variations, Review and editing of the main manuscript and approval of the final version. **JU** – Review and editing of the main manuscript and approval of the final version

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