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Research Article

Morphological variations of Caudate and Quadrate lobes of liver: A Clinicoanatomical insight

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Abstract

The liver is the largest wedge shaped abdominal viscera, situated under the right dome of the diaphragm occupying right hypochondrium and epigastric region. The organ is divided into right and left lobes by the falciform ligament, fissure for ligamentum teres and fissure for ligamentum venosum. A sound knowledge of normal anatomy and morphological variations of liver is important for radiographic imaging and minimally invasive surgical approaches.

The present study was conducted on 32 liver cadaveric specimens collected from routine cadaveric dissection for teaching undergraduate students. The accessory fissures and accessory lobes were observed in 18(56.25%) and 4(12.5%) specimens. The caudate lobe displayed accessory fissures in 12(37.5) % and accessory lobes in 1(3.125%)of the specimens. The quadrate lobe presented the accessory fissures and lobes in 6(18.75%) and 3(9.375%) specimens respectively. Quadrate lobe communicated with the left lobe, as the fissure for ligamentum teres was incomplete in 6(18.75%) specimens. Also, a communication was observed between quadrate lobe and right lobe in 5(15.625%) of the specimens. Fossa for gall bladder was incomplete in 16(50%). One of the specimens displayed a unique presentation with enlarged caudate lobe and a hypertrophied papillary process.

Hepatic surface variations are important for radiologists in making accurate diagnosis during imaging and is a prerequisite for gastroenterologists for better surgical outcome. Henceforth the present study was conducted to observe the morphological variations of the lobes of liver and structures in vicinity.

Keywords: *Caudate lobe, Quadrate lobe, Papillary process, Accessory lobe, Pons hepatis, Ligamentum teres.*

Introduction

The liver is the largest abdominal organ occupying right hypochondrium, epigastrium and left hypochondrium extending as far as the left axillary line. Anatomically the organ is divided into a larger right and a smaller left lobe by falciform ligament anteriorly, fissure for ligamentum venosum and ligamentum teres posteriorly[1]. The right lobe, forming five-sixth of the organ includes caudate and quadrate lobes separated from each other by porta-hepatis. Quadrate lobe, roughly rectangular in shape is bounded anteriorly by inferior border, posteriorly by porta hepatis, on the left by fissure for ligamentum teres and on the right by fossa for gall bladder. Caudate lobe is bounded by groove for inferior vena cava on the right, fissure for ligamentum venousm on left, inferiorly by porta hepatis and superiorly it is continous with the superior surface. The caudate lobe presents a narrow projection inferiorly and towards the right, called as caudate process. It also presentsa small and rounded papillary process to the left[2].

Physiologically the liver is divided into right and left lobes by the Cantlie's line. The line extends from the mid-point of groove for inferior vena cava superiorly to the midpoint of fossa for gall bladder inferiorly[1].

Morphological variations of liver can be either congenital or acquired. Congenital anomalies include agenesis, atrophy, accessory lobes, accessory fissures or hypoplasia of the lobes. Acquired variations however are attributed to the pressure given by diaphragm, peritoneal ligaments and other related organs in the vicinity[3]. Congenital anomalies of liver may occur due to defective or excessive development of the organ. Defective development of left lobe may result in gastric volvulus and right lobe may lead to portal hypertension. Excessive development of the organ results in formation of accessory lobes[4]. The presence of additional or accessory lobe had been misinterpreted as a lesser omental lymphadenopathy at the time of preoperative imaging[5]. Further the accessory lobe may herniate into the thoracic cavity thereby causing serious complications[6].Thus variations in the morphology of the organ is of immense importance for surgeons to plan and perform surgical procedures and radiologists to prevent possible misinterpretations.

Though the branching segmental pattern of liver and biliary system has been studied extensively, there are few studies regarding the surface variations of the liver including irregularities of form, presence of various cysts and number of lobules[7]. Henceforth the present study was conducted to examine the morphological features of human cadaveric liver specimens and to assess anatomical variations of caudate and quadrate lobes. Further these variations were correlated with the clinical significance and implications.

Materials and Methods

The present study was conducted in the Department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital. The study included thirty two specimens of liver collected from routine cadaveric dissection for teaching undergraduate students. The specimens were numbered and observed for various morphological variations. The observations were divided into four categories as follows:

1. ANOMALIES RELATED TO CAUDATE LOBE
   a. Accessory fissures
   b. Accessory lobe/lobes projecting from the caudate lobe
2. ANOMALIES RELATED TO QUADRATE LOBE
   a. Accessory fissures
   b. Accessory lobe/lobes projecting from the quadrate lobe
   c. Communication of Quadrate lobe with the left lobe
   d. Communication of Quadrate lobe with the right lobe
3. ANOMALIES RELATED TO FISSURE FOR LIGAMENTUM TERES

4. ANOMALIES RELATED TO FOSSA FOR GALL BLADDER

Results

In the present study, the incidence of accessory fissures and accessory lobes are 56.25% and 12.5% respectively (Table 2). The accessory fissures related to caudate lobe were present in 12(37.5%) specimens (Fig.1, 7, 8, Table 1). A kidney shaped accessory lobe projecting from the lower part of caudate lobe was observed in one (3.125 %,) of them (Fig.2, Table 1). Enlarged caudate lobe with hypertrophied caudate process was present in one (3.125%) specimen [Fig.3, Table1]. Accessory fissures and accessory lobes related to quadrate lobe were noted in 6(18.75%) and 3(9.375%) specimens respectively (Fig.4, 5, 7, 9, Table 1). Fissure for ligamentum teres was incomplete, leading to a communication between quadrate and left lobe in 6 (18.75%) specimens (Fig.6, Table 1). Quadrate lobe communicated with right lobe in 5 (15.525%) specimens (Fig.1, 4, Table 1). Further, fossa for gall bladder was incomplete in 16(50%) of the specimens.

Table 1 Incidence of variations of liver morphology observed in the present study

MORPHOLOGICAL FEATURES	NUMBER OF SPECIMENS	PERCENTAGE
1.ANOMALIES RELATED TO CAUDATE LOBE		
a. Accessory fissures	12	37.5%
b. Accessory lobe projecting from the caudate lobe	01	3.125%
c. Enlarged caudate lobe with hypertrophied caudate process	01	3.125%
2.ANOMALIES RELATED TO QUADRATE LOBE		
a. Accessory fissures	6	18.75%
b. Accessory lobe projecting from the quadrate lobe	3	9.375%
c. Communication of quadrate lobe with the left lobe(pons hepatis)	6	18.75%
d. Communication of quadrate lobe with the right lobe	5	15.625%
3.ANOMALIES RELATED TO FISSURE FOR LIGAMENTUM TERES		
a. Incomplete fissure for ligamentum teres	6	18.75%
4.INCOMPLETE FOSSA FOR GALL BLADDER	16	50%

Table 2: Comparision of the Incidences of variations of the present study with previous studies

S.NO	STUDY	Accessory fissures	Accessory lobes	Communication of Quadrate lobe with the right lobe	Communication of Quadrate lobe with the left lobe(PONS HEPATIS)
1.	Present Study	56.25%	12.5%	15.625%	18.75%
2.	Vinnakota et al	53.44%	17.24%	-	-
3.	Chaudari HJ et al	23.7%	3.7%	-	1.25%
4.	Patil S et al	10%	10%	-	10%
5.	Chin J et al	27%	24%	-	36%
6.	Wahane A et al	20%	16%	-	-
7.	Singh HR et al	60%	12.86%	-	22.86%

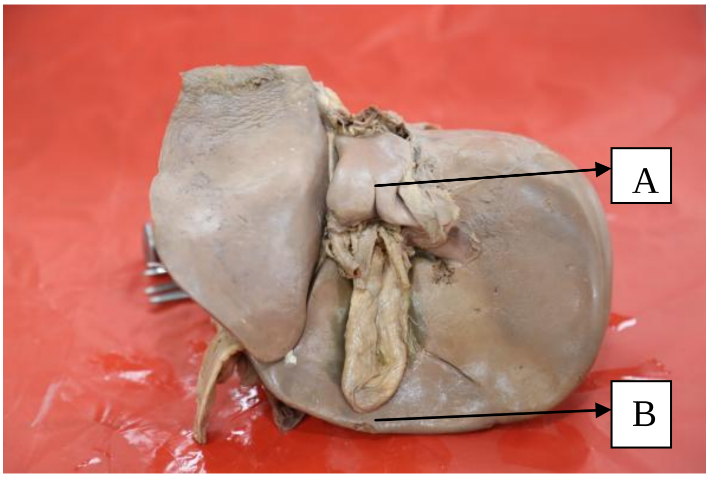

Fig.1: Inferior surface of the liver showing (A) accessory fissure in the caudate lobe and (B) Communication of quadrate lobe with the right lobe.

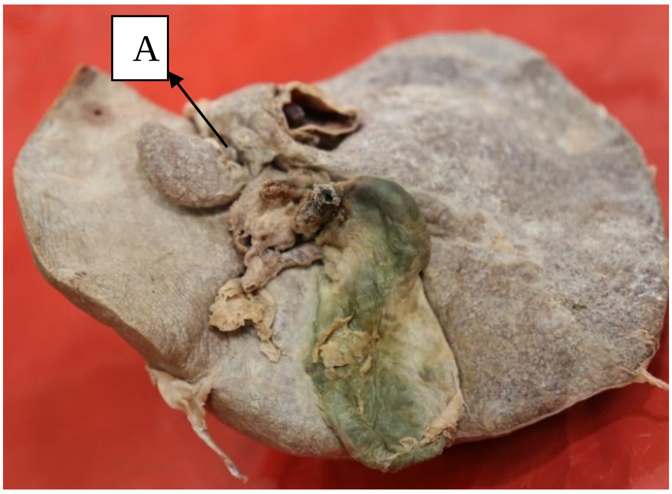

Fig.2: Inferior surface of the liver showing (A) kidney shaped accessory lobe projecting from the caudate lobe.

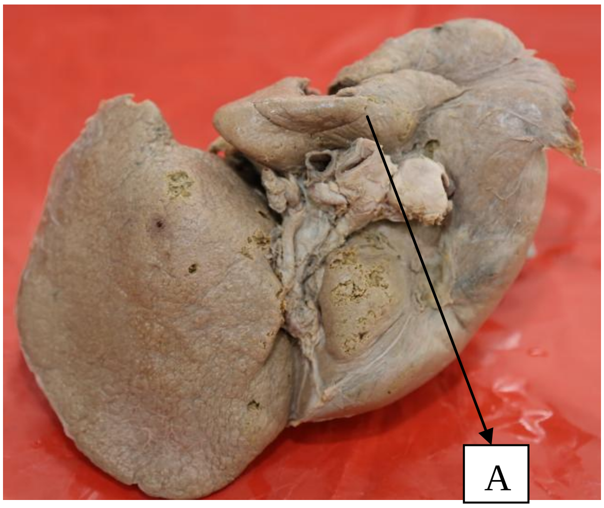

Fig.3: Under surface of liver showing (A) enlarged caudate lobe with hypertrophied caudate process.

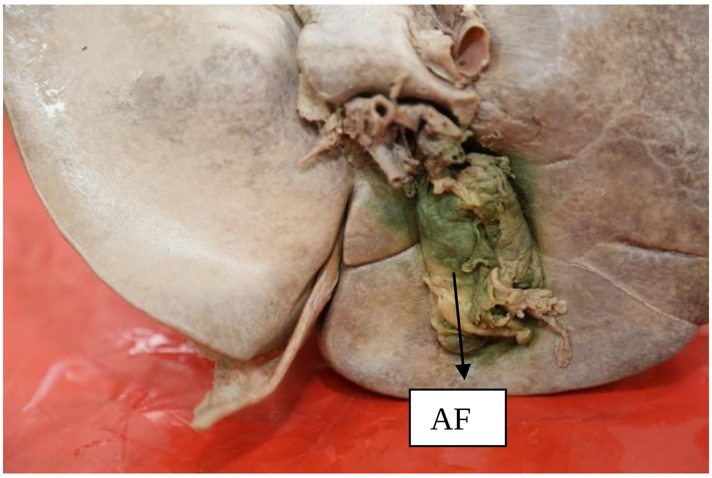

Fig..4: Undersurface of the liver showing (AF) accessory fissure related to quadrate lobe

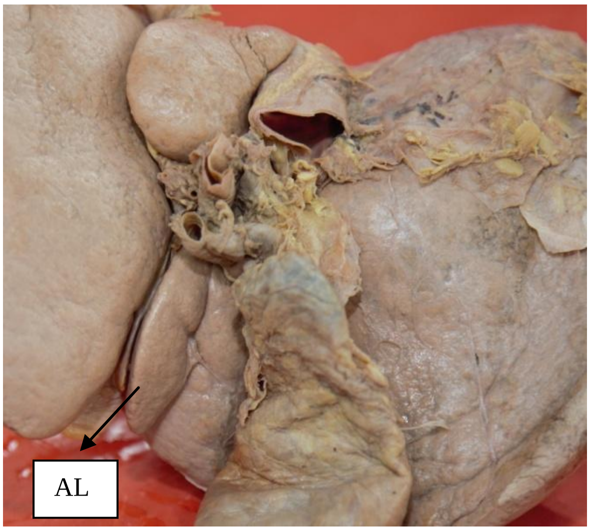

Fig.5: Inferior surface of the liver showing (AL) accessory lobe projecting from quadrate lobe

Fig.6: Undersurface of the liver showing (→) incomplete fissure for ligamentum teres and communication of quadrate lobe with the the left lobe of the liver.

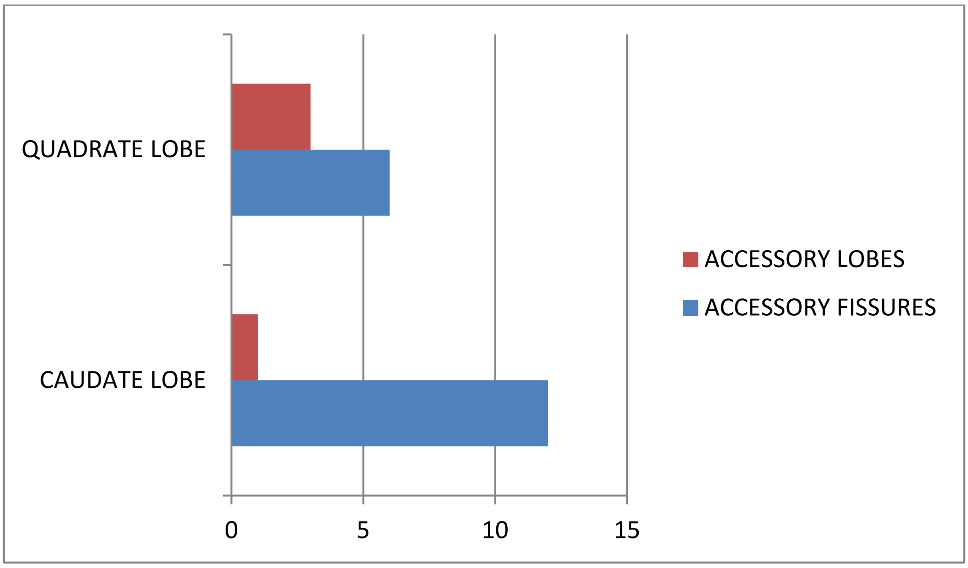

Fig.7: A Bar diagram showing the comparison between number of accessory fissures and lobes in Quadrate and Caudate lobes.

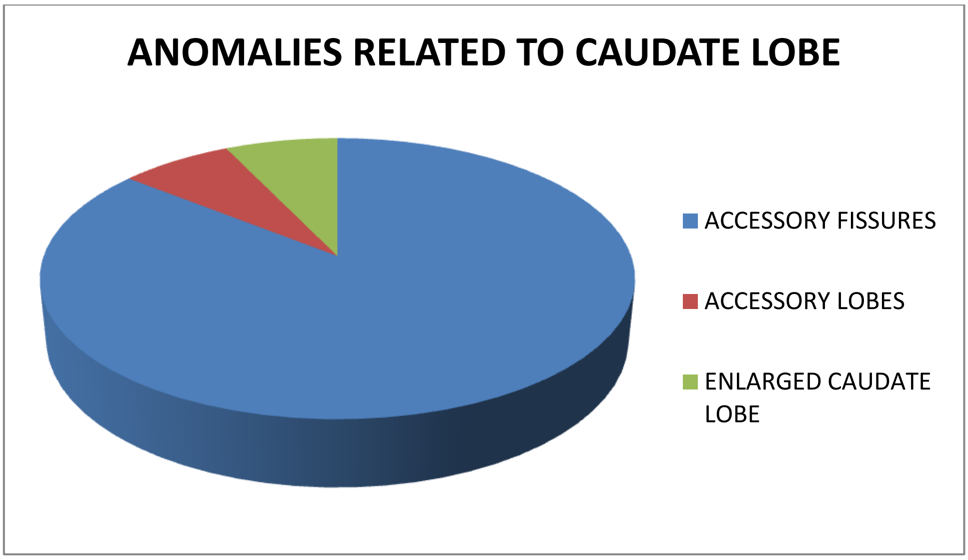

Fig.8: A Pie chart showing the distribution of different variations found in the Caudate lobe.

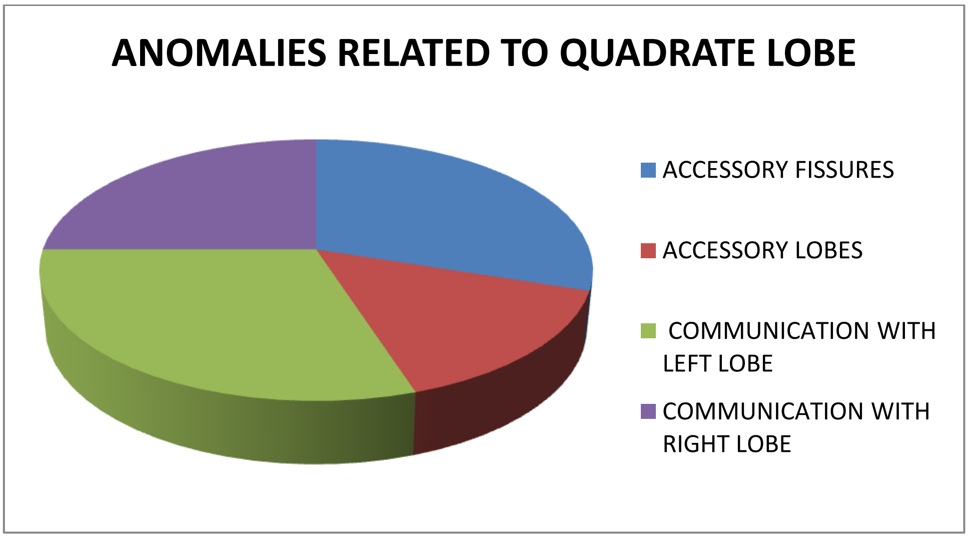

Fig.9: A Pie chart showing the distribution of different variations found in the Quadrate lobe.

Discussion

The organogenesis of the liver begins during third week of intrauterine life and its primordium appears as an endodermal outgrowth at the distal end of the foregut. The outgrowth is termed as liver bud and it consists of cells which proliferate rapidly penetrating the septum transversum[8]. The part of mesoderm of the septum transversum that lies between liver and foregut forms the lesser omentum and the part lying between ventral abdominal wall and liver forms the falciform ligament. Reflections of the peritoneum from the diaphragm to the liver forms the anterior and posterior coronary ligaments[8].

Despite the complicated development, gross abnormalities of liver are rare[7]. The morphological variations of liver can be classified as congenital or acquired. The congenital anomalies of liver include agenesis and atrophy of lobes, absence of segments, deformed and hypoplastic lobes. They may also be sometimes associated with abnormalities related to diaphragm and suspensory ligaments of the liver[4].

In the present study accessory fissures were observed in 56.25% of the specimens (Table 2). The incidence being 37.5% in caudate lobe (Fig.1, Table 1) and 18.75% inquadrate lobe (Fig.4, Table 1). Compared with previous studies, the accessory fissures were reported in different populations of India as53.44%[2], 23.7%[9],10%[10], 20%[7], 60 %[11]. However their occurrence in American population was found to be 27%[12] (Table 2).

The incidence of accessory lobes observed in the present study was 12.5 % (Table 2), 3.125% in caudate lobe and 9.375% in quadrate lobe (Table 1). The caudate lobe displayed kidney shaped accessory lobe projecting towards the left lobe from its lower part (Fig. 2). One of the liver specimens presented a unique picture depicting enlarged caudate lobe with hypertrophied caudate process (Fig.3, Table 1). The quadrate lobe also displayed kidney shaped accessory lobe extending vertically from the porta hepatis to the inferior border (Fig.5). In previous studies, the incidence of accessory lobes was reported to be 17.24 % [2], 3.7%[9], 10%[10], 16%[7], 12.86%[11] in Indian populations and 24% in American population[12] (Table 2).

Fissure for ligamentum teres was incomplete in 6 (18.75%) specimens (Fig.6, Table 1). The incomplete fissure resulted in a communication between quadrate and the left lobe, termed as Pons hepatis or hepatic bridge or pont hepatique[12]. In previous studies, the incidence of Pons hepatis was reported to be 1.25%[9], 10%[10], 22.86%[11] in Indian populations and 36% in American population[12] (Table 2). However, in the current study, Pons hepatis was recorded in 6(18.75%) (Table 1, fig 6) specimens. Pons hepatis is favoured site for secondaries from the primary tumours of the peritoneal cavity. Further the pons hepatis segment may also give rise to metastatic hepatomas[19]. It is considered to be an essential landmark for Cryoreductive surgeries[20,21].

The accessory fissures are of immense clinical significance as they may be misinterpreted during radiographic imaging. These fissures appear as single or multiple thin lines radiating inward from the periphery of the organ[9]. Accumulation of fluid in such fissures might be confused with liver cyst, intrahepatic haematoma or liver abscess[13]. Secondaries or disseminated tumour cells from the primaries in the peritoneum may migrate into into these fissures and they might be misinterpreted as intrahepatic focal lesions. Further they may be wrongly diagnosed for macronodular liver on sonography[13] or erroneouslyas a case of liver laceration during imaging or palpation, if the patient has a history of abdominal trauma[14].

Accessory lobes, though commonly found on the undersurface of the liver may be also present on the gallbladder surface, adrenal glands, pancreas and the thoracic cavity[15]**.** It is composed of normal parenchymal tissue communicating with the main liver mass and can be differentiated from ectopic liver as the latter may found at a distant sites[11,12]. Moreover, ectopic liver has been observed to be more prone to malignancy as compared to main liver parenchyma[16]. Accessory hepatic lobes needattention especially if there is a torsion of the vascular pedicle or metastasis occurring in them. Torsion of the accessory lobes is a surgical emergency and it has to be attended to the earliest. Damage to this lobe or its vascular pedicle may result in torrential bleeding into the abdominal cavity proving to be a vascular catastrophe[17,18].

This study on anatomical variations of caudate and quadrate lobes of the liver envisages to record the notable anomalies such as accessory fissures and lobes for the benefit of hepatic surgeons and radiologists. This detailed morphological experiment on the liver will prove of immense value for making the accurate diagnosis and planning surgical treatment accordingly. A thorough knowledge of these accessory fissures and lobes is of paramount utility for the radiologists and surgeons to avert post-operative complications.

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