

## An unusually notched liver by the diaphragmatic sulci and inferior surface showing the accessory fissures

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Received 04 June; accepted 21 July; published online 01 August; printed 16 August 2013

### ABSTRACT

The abdominal dissection of a female cadaver revealed an unusually notched liver with two diaphragmatic sulci extending from the superior surface to the upper part of the anterior surface. The liver was normal in size weighing about 1200 gms and occupied the entire right hypochondrium, extended into left hypochondrium passing through the epigastrium. The specimen was dissected out from the body. All its surfaces were carefully observed. The indentations caused by the muscle fibres of the diaphragm are seen over the right surface forming faint grooves. Also, the inferior surface showed presence of two accessory fissures.

**Keywords:** Antero-superior surface, Diaphragmatic sulcus, Accessory fissure, Inferior surface

**Abbreviation:** CT scan – Computerized axial Tomogram, AF – Accessory Fissure

### 1. INTRODUCTION

The liver is the magnificent organ of re-generation besides being the largest gland of the human body measuring about 1.5 to 1.8 kgs (accounting for approximately 2% to 3% of total body weight of an individual). The liver is one of the first organs to develop in the embryo (John E. Skandalakis, 2004). It is situated in the right upper quadrant of the abdomen and lies under the right dome of diaphragm. It has the ligaments namely falciform ligament anteriorly, the fissure for ligamentum venosum posteriorly and the fissure for ligamentum teres inferiorly. Dividing it into large right lobe and a small left lobe (Standing, 2005). The liver presents anatomical and physiological right and left lobes, caudate and quadrate lobes, and sometimes Riedel's lobe. It is supplied by portal vein (70-75%) and hepatic artery (25-30%). It is drained by hepatic veins which finally empty into the inferior vena cava. The diaphragm is related to the superior surface of the liver and may exert Diaphragmatic / costal pressure resulting in the formation of the diaphragmatic sulci. The discovery of these diaphragmatic sulci is incidentally reported during radiological procedures or autopsy study (Auh, 1984). Accessory fissures are frequently found on the hepatic surface. The grooves have various lengths, being linear or curved in shaped and single or multiple in numbers. These have been investigated as congenital development or acquired due to diaphragmatic or costal pressure (Zahn, 1882; Thomson, 1899; Newell, 1933). The development of the accessory sulci could be due to genetic predisposition (Macchi, 2005; Suksaweang,

2004). The span of activity and shift of growth zones in the liver are dependent on beta-catenin/Wnt activity. If there is any failure of genetic guidance especially in the younger age group, it can lead to the formation of sulci (Suksaweang, 2004).

### 2. SCOPE OF THE STUDY

The diaphragmatic sulci and accessory fissures may mimic the major hepatic fissures on sectional images. Their average incidence on computed tomographic (CT) scans is 25%. They occur more frequently in women. Their frequency increases with the age and may reach a depth of one or two cm may be even deeper in one third of the cases. The multiple accessory fissures may mimic pathologic liver nodules on CT scans. They may be associated with diaphragmatic scalloping and eventration on the chest skiagrams. Diagnostic errors can be avoided if the morphology and normal distribution of these fissures are well understood. Major and minor grooves of the liver play a crucial role in hepatectomy as they are significant in the anatomic evaluation and for the better surgical understanding of the liver. They are useful not only for the localization of the tumor but also for marking the resection margins in hepatectomy.

#### 2.1. Materials

An embalmed elderly female cadaver along with routine dissection instruments like, Scalpel, Blade, Surgical forceps, Anatomical Forceps, Dissector, Metallic Scale with Calibrations, a pair of gloves were required.

#### 2.2. Methodology

#### Bare area of the liver:

It is defined as the area of liver which is not covered by peritoneum there are four extensive non-peritoneal areas.

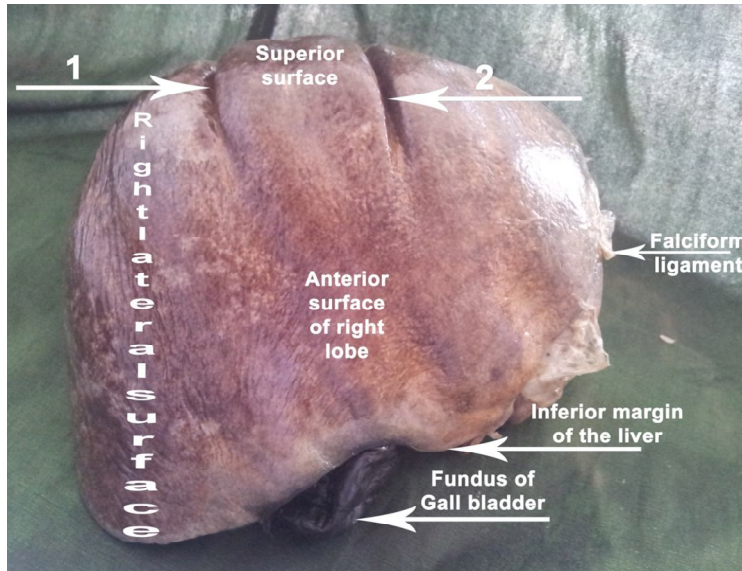
1. Groove for inferior vena cava.
2. Fossa for gall bladder.
3. A small area on the upper surface of the liver.
4. Larger triangular area on the posterior surface of right lobe.

#### Portal systemic circulation:

It is a component of the cardio vascular system which begins in the capillaries/sinusoids and ends in the capillaries/sinusoids. Eg: Portal vein formed by superior mesenteric vein and splenic vein behind the neck of pancreas ends by dividing into hepatic sinusoids.

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**Figure 1**

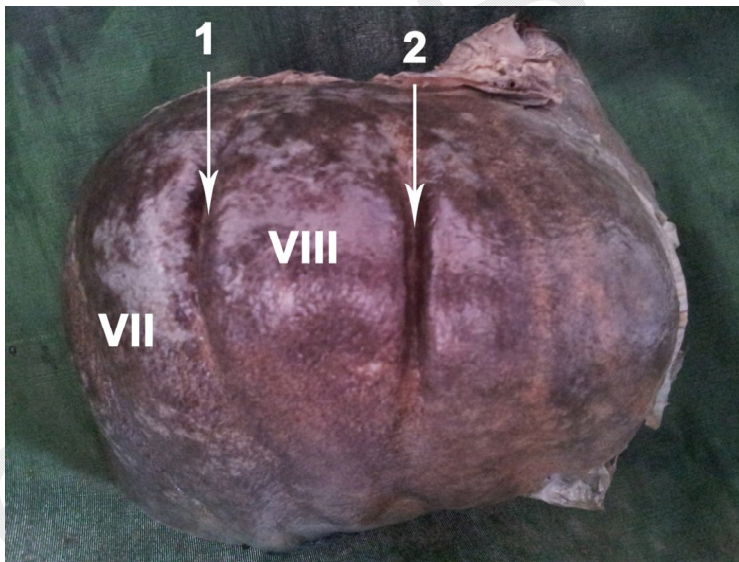
Antero superior and right lateral surfaces of the right lobe of the liver (Dissected out specimen). 1 & 2 ARE THE DIAPHRAGMATIC SULCI SEEN ON THE SUPERIOR SURFACE OF THE RIGHT LOBE OF THE LIVER EXTENDING MINIMALLY OVER TO THE ANTERIOR SURFACE. THE FIRST SULCUS IS SHALLOWER IN DEPTH AND SHORTER IN LENGTH THAN THE SECOND FISSURE. NOTE: INDENTATION CAUSED BY THE MUSCLE FIBRES OF THE DIAPHRAGM ARE SEEN OVER THE RIGHT LATERAL SURFACE FORMING FAINT GROOVES.

**Porta hepatis:**

It is a transverse non-peritoneal fissure acting as a gate way of the liver. It extends from the neck of gall bladder to the fissures for the ligamentum teres and venosum. It is present in between the quadrate lobe (front) and caudate process (behind). The right and left hepatic ducts, cystic duct, and lymphatics exit the liver through it. The right and left divisions of portal vein, the right and left branches of hepatic artery, hepatic plexus of nerves enter into the liver through it.

**Pons hepatis:**

A band of liver tissue bridging the back of inferior vena cava, and converting the groove into tunnel is called pons hepatis



**Figure 2**

Superior surface of the right lobe of the liver (Dissected out specimen) THE SECOND DIAPHRAGMATIC SULCUS IS SEEN TO BE MUCH DEEPER. THAN THE FIRST DIAPHRAGMATIC FISSURE. THE LIVER GETS A NOTCHED APPEARANCE AND THE SUPERIOR SURFACE OF THE SEGMENT VIII IS SEEN BULGING UPWARDS.

A median vertical incision was made from the xiphoid process to the pubic symphysis. The large skin flaps, musculo aponeurotic flaps were reflected laterally. The anterior abdominal was dissected layer by layer. The horizontal and vertical reflections of the peritoneum were studied in detail. The liver present in the right hypochondrium covered under the dome of diaphragm showed fissures on its antero superior surface which was dissected out. All its surfaces were observed and studied in detail.

**3. RESULT / OBSERVATION**

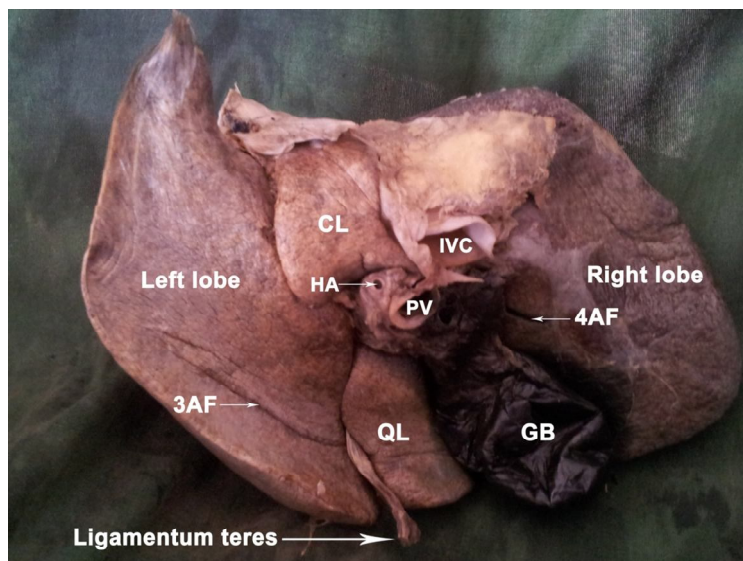
During the routine prosection hours as a teaching programme for undergraduate medical students of 1<sup>st</sup> year M.B.B.S students at Shadan Institute of Medical Sciences Teaching Hospital & Research Centre, the dissected female cadaver revealed an unusually notched liver with two diaphragmatic fissures extending as prominent vertical grooves over the antero-superior surface (Figure 1, 2 & 4). The liver was normal in size weighing about 1200 gms and occupied the entire right hypochondrium, extended into left hypochondrium passing through the epigastrium. The specimen was dissected out from the body. All its surfaces were carefully observed. The indentations caused by the muscle fibres of the diaphragm are seen over the right lateral surface forming faint grooves (Figure 1). The first diaphragmatic fissure was shallow with a depth of 0.2 cm and measured 3 cm long. The second diaphragmatic fissure was much deeper with a depth of 0.4 cm and longer measuring 3.7 cm (Figure 2 & 4). The liver appeared notched with the portion between the fissures bulging upwards (Figure 2). The right lobe was larger than the left lobe. The inferior surface of the left lobe revealed a very long, oblique and shallow accessory fissure extending towards the quadrate lobe (Figure 3). The inferior surface of the right lobe of the liver revealed a shorter but deeper accessory fissure, just adjacent to the porta hepatis.

**4. DISCUSSION**

From 420 cadaveric dissections 79 grooves on the diaphragmatic surfaces of 50 livers were observed. Most grooves were located within segment VIII wholly (31/79) or partially (39/79). By contrast, only 11 grooves corresponded to the border between two segments (segments VIII/IV in 6 cases and segments VIII/VII in 5 cases). Diaphragmatic indentations (fold-like protrusions) into the groove were observed in only one case (Ono, 2000). Hence, the present variation discovered is a rarity. After observing 175 formalin fixed livers it was discovered that only 18% of them showed accessory deep fissures. There were 3 to 4 in number on the inferior surface of the right lobe but did not show any veins in their depth (Senthil Kumar, 2012). The present case report discovered reveals the occurrence of two accessory fissures on the inferior surface of both right and left lobe, besides the two diaphragmatic sulci over the antero superior surface.

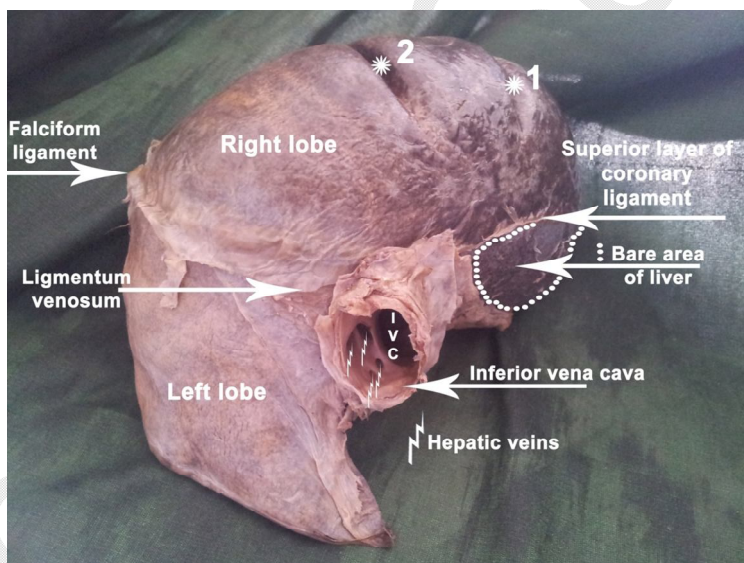
After studying extensively 90 formalin fixed livers, the prominent vertical grooves on the antero-superior surface were found in 6% of the livers. The posterior and the inferior surfaces of the right lobe were found to be the common sites of presence of accessory fissures (Joshi et al. 2009). In the present case two prominent diaphragmatic fissures were seen on the antero superior surface of the right lobe and two accessory fissures on the inferior surface of both right and left lobes.

After observing 40 liver specimens the accessory sulci were discovered in only two specimens. In one of the specimen the accessory sulcus was close to the colic



**Figure 3**

The inferior surfaces of the right & left lobes of the liver (Dissected out specimen) 1AF & 2AF POINT OUT AT THE ACCESSORY FISSURES SEEN ON THE INFERIOR SURFACES OF RIGHT & LEFT LOBES RESPECTIVELY. 1AF – IS LONGER AND SHALLOWER FISSURE COURSING OBLIQUELY FORWARDS AND DOWNWARDS. TOWARDS THE LIGAMENTUM TERES 2AF – IS SHORTER AND DEEPER FISSURE PRESENT BY THE SIDE OF PORTA HEPATIS ON THE INFERIOR SURFACE OF THE RIGHT LOBE.



**Figure 4**

The postero superior surfaces of the right & left lobes of the liver (Dissected out specimen). THE HEPATIC VEINS ARE SEEN OPENING INTO THE INFERIOR VENA CAVA.

impression on the inferior surface of the right lobe measured 2.7 cm vertically. The second specimen showed accessory

sulcus on the posterior surface of the upper part of the right lobe measured 1.5 cm transversely (Faizah B. Othman, 2008). In the present case both the accessory fissures were observed on the inferior surface of the liver. The sulcus present on the inferior surface of the left lobe was long and shallow while the other on the inferior surface of the Right lobe was short and deep. A very large liver occupying the epigastrium, right and left hypochondriums with two deep notches on the antero-superior surface of its right lobe. Interesting feature was that the left lobe was larger than the right lobe and caecum was sub-hepatic in position (Nayak, 2012). The present case report also had similar double notches on the antero superior surface but the right lobe was larger than the left lobe. As the liver was normal in size the caecum was not subhepatic. The diaphragmatic sulci are mostly localized in the superior surface of the right lobe and rarely on the left lobe (Zahn, 1882). These sulci were narrow with variable depths ranging from 1 to 2 cm. sometimes they can be multiple ranging from 2 to 6 sulci, and are seen more frequently in females aged over 15 years (Yamagiwa, 1907). The present case was discovered in an elderly female cadaver. The diaphragmatic sulci were two in number, present on the antero superior surface of the right lobe of liver. The accessory hepatic fissures / sulci are potential sources of diagnostic errors during imaging. Any collection of fluid in them may be mistaken for a liver cyst, intrahepatic haematoma or liver abscess. Implantation of peritoneally-disseminated tumour cells into these spaces may mimic intrahepatic focal lesions (Auh et al. 1994).

### 5. CONCLUSION

Hepatology is complete only with the knowledge of the diaphragmatic sulci and accessory fissures. The medical personnel including the Radiologists, Hepato-Biliary surgeons should be aware of such rare variations which can lead to erroneous interpretation of skiagrams, tomograms and cause confusion during operations. At times as these sulci / fissures may mimic any injury to the liver during post mortem study, the Forensic personnel should be aware of them.

### SUMMARY OF RESEARCH

The present case report discovered the rare incidence of two diaphragmatic sulci and two accessory fissures in an elderly female cadaver which was in its fifth decade. The linear diaphragmatic sulci were present on the antero superior surface of the right lobe of the liver. The inferior surface of both the right and left lobes showed shorter and longer accessory fissures respectively. There were no veins observed in the depth of these fissures.

### FUTURE ISSUES

In the modern era the cadaveric liver transplantations can also be promising just like today's renal transplantations. The routine anatomy text books do not mention the presence of diaphragmatic and accessory sulci. The research reports are the only source of information.

### DISCLOSURE STATEMENT

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### Comparison

The clinical relevance of grooves on the hepatic surface has not been clearly identified. It is suggested that the grooves do not seem to be critical landmarks for segmental borders of the liver because they are formed during a later stage of diaphragmatic growth after establishment of the basic segmental configuration (Ono et al, 2000). However, few others reported that the main accessory sulcus may represent a marking for the right portal fissure, and a superficial reference for the deep course of the right hepatic vein (Macchi et al, 2005). It is also proposed that the surface projections of portal fissures could be used as superficial landmarks (Couinaud, 1957; Fasel, 1998). Occurrence of diaphragmatic sulci resulted from the uneven growth of the hepatic parenchyma caused by variable resistance offered by different bundles of the diaphragm muscle (Macchi et al, Feltrin, 2003). Recent radiological and corrosion casts showed the formation of sulci is due to existence of weak zones of hepatic parenchyma, represented by the portal fissures between the adjacent sagittal portal territories these weak zones offer lower resistance to the external pressure of the diaphragm (Macchi et al. 2005).

### Content

Liver (hepato) was called a "hostile" organ as it welcomes the malignant cells and infection due to its tendency of copious bleeding (Longmire WP. 1982). Frequently it is the first organ to be injured in cases of blunt abdominal trauma. It is an organ of great ability of regeneration. The liver is both exocrine and endocrine gland. The exocrine part secretes bile which is conveyed by the biliary passages. The endocrine part liberates useful chemicals such as glucose, heparin, plasma proteins directly into the blood stream.

There is no financial support for this research work from the funding agency.

### ACKNOWLEDGEMENT

This case report is dedicated to our Chairman Sir "Dr. VIZARATH RASOOL KHAN" with utmost reverence and motherly affectionate "SHADAN" Madam as they have been always very kind and understanding. Deep from our heart we pray for their Long Life & Well Being. Thanks to J. George William the Digital librarian Shadan Institute of Medical Sciences Teaching Hospital and Research Centre and his family for all the support extended. Thanks to S. Tataj Varma and his family for typing the manuscript. Thanks to all the students whom so ever I have taught for their constant inspiration and encouragement.

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