Cadaveric study on the presence of grooves/fissures on diaphragmatic surface of liver in north Indian population

Ruchi Sharma[1] , Yogesh Yadav[2], Ashish Gautam[3] , Lovenish[4], Nisha kaul[1], Pankaj Wadhwa[5*]

[1] Santosh Medical college, Ghaziabad, Uttar Pradesh- 201204, India

[2] Noida International Institute of Medical Sciences, Noida, Uttar Pradesh - 201301, India

[3] Yashoda Super Specialty Hospital, Ghaziabad, Uttar Pradesh- 201001, India

[4] Dept. Of Surgery, Maulana Azad Medical College New Delhi-110002, India

[5] School of Pharmaceutical Sciences, Lovely Professional University, Phagwara, Punjab – 144 411, India

Corresponding Author: Dr. Pankaj Wadhwa

School of Pharmaceutical Sciences, Lovely Professional University, Phagwara, Punjab – 144 411, India

Email:pankajwadhwa88@gmail.com

Phone: +91-0461754780 .

Abstract

Background: The liver is a unique organ with many distinct anatomical and physiological characteristics. It is a major gland in the human body, wedge-shaped, and situated beneath the right dome of the diaphragm. Its diaphragmatic surface is normally smooth, however it may be grooved at times. These grooves vary in size and shape, and their number, form, and size can range from one to numerous.

Material & Methods: In Santosh Medical College, Ghaziabad, the study was conducted on 100 liver specimens. All the specimens are preserved in the 10% formaldehyde in formalin tanks. The diaphragmatic surface of all the livers was thoroughly examined for the existence of grooves/fissures/notches/sulci, and the observations were noted and images were taken.

Result: 18 livers had fissures/ grooves on their diaphragmatic surface. A total of 38 grooves/fissures were observed. All these grooves and fissures are present on the right lobe of liver only. All of these fissures/grooves are parallel to one another and to the sagittal plane. In the 6 specimens of liver only one groove/fissure was observed while in 12 specimens of liver the multiple grooves/fissures were observed.

Conclusion: All of these grooves are parallel to each other and to the sagittal plane, indicating that they are not cough furrows or caused by a corset. The knowledge of the grooves/fissures is important for anatomist, embryologist, radiologist, surgeons, and forensic experts during their routine procedures.

Keywords: Diaphragmatic fissures, grooves, notches, sulci, liver.

DOI Number: 10.48047/nq.2022.20.19.NQ99165 **NeuroQuantology2022;20(19): 1907-1915**

INTRODUCTION

The liver, the second-largest organ in the human body and the most efficient gland, is found in the right hypochondrium, epigastrium, and a little area of the left hypogastric region, all of which are located beneath the right dome of the diaphragm. The enormous right and tiny left lobes, which have both exocrine and endocrine roles, are divided by the ligamentum venosum, which attaches anteriorly, the ligamentum teres, which connects inferiorly, and the ligamentum venosum[1,2]. Human morphological variations have been divided into congenital and acquired categories. Agenesis of lobes, accessory hepatic fissures, sulci, hypoplasia of lobes, hyperplasia, atrophic and hypoplastic lobes are examples of congenital abnormalities of the liver. Diaphragm muscles, the peritoneal ligament, and adjacent organs all exert pressure on the liver, which results in acquired variations of the liver [3,4]. Liver diaphragm surfaces are typically smooth, however they can rarely have grooves. The diaphragmatic fissures come in a variety of sizes and shapes. They could be straight, horizontal, or curved. They could be one or numerous[5]. There is disagreement among authors about the cause of diaphragmatic fissures; some think it is congenital and others think it is a genetic predisposition [6]. Medical literature continues to dispute the genesis of diaphragmatic fissures in humans despite the fact that there are numerous ideas about their development [3,5]. Several other findings state that the majority of the accessory fissures and sulci on the anterosuperior surface are located in the right lobe of the liver. The diaphragm muscles' pressure causes these fissures, grooves, and sulci, which can be shallow or deep [3,7]. Apart from this, while doing radiological procedures, Auh Y H reported discovering diaphragmatic sulci by accident [8]. The diaphragmatic sulci were also identified in radiological studies as changes of the liver [12,13]. However, Newell and Morgan-Jones hypothesised that postmortem artefact could be the cause of the sulci's formation [5]. In another autopsy research, Ono et al. discovered a greater frequency of diaphragmatic sulci [9]. Yadav and his co-workers unintended found the additional sulci on the liver's anterosuperior surface during a laprotomy [10]. In several investigations of post-mortem studies, sulci and grooves on the anterosuperior surface of the liver were also identified [11]. There hasn't been any investigation into the embryological basis for the development of the diaphragmatic grooves on the liver's anterior side [14]. According to certain research, persistent coughing causes sulci and grooves on the liver's anterosuperior surface, which have been designated "cough furrows" in illnesses including asthma, COPD, chronic bronchitis, pulmonary tuberculosis, etc [10]. Some report also stated that they were caused by wearing a tight corset to restore posture in cases of scoliosis or to achieve the ideal attractive shape, referring to it as "corset liver" or "ribbed liver"[15]. The occurrence of auxiliary grooves, sulci, furrows, notches, and

fissures on various hepatic surfaces has been the study of numerous radiographic and surgical studies, but there have not been many cadaver studies. In the current study, we describe the occurrences of these diaphragmatic sulci/fissures on the liver's anterior, superior, posterior, and right lateral surfaces, analyse their orientation, and quantify their length, breadth, and depth.

MATERIAL AND METHOD

The anatomy department at Santosh Medical College in Ghaziabad, Uttar Pradesh, India, conducted the study on 100 cadaveric livers (male and female). The cadaveric livers are between 15 and 70 years old. The livers were put to use in ordinary medical student demonstration classes. The study comprised all of the livers over the previous 12 years that were kept in formalin containers with a 10% formaldehyde concentration. The study excluded livers that were damaged and livers that had a clear disease appearance. On the liver's diaphragmatic surface, we discovered grooves, fissures, sulci, notches, and furrows. The liver's diaphragmatic surface is closely examined for the existence of aberrant grooves, and the observation and data collected are documented. Images of the specimen with the unusual grooves that were pertinent were obtained.

OBSERVATIONS

A total of 100 cadaveric liver specimens were examined in the current study. The diaphragmatic surface of 18 of the livers contained fissures, grooves, notches, or sulci. The diaphragmatic surface of the liver has only grooves or fissures that extended from the right lateral surface to the anterior surface or across the superior surface of the liver from the anterior to the posterior surface. The fissures ranged in size from single to numerous, shallow to deep, and narrow to wide. All of these grooves were perpendicular to the sagittal plane and to one another. These grooves were all present in the liver's right lobe but not in the left. Six liver specimens had a single sulcus, fissure, or groove, whereas twelve liver specimens had several sulci, fissures, or grooves. A single, broad, deep diaphragmatic fissure formed a significant, apparent notch on the anterosuperior surface of the right lobe of the two livers, and the area of liver medial to it bulged upward. Two grooves, fissures, or sulci were identified on the antero-superior surface of the liver in eight livers, resulting in three livers with a notched appearance. There was only one diaphragmatic fissure, and it was shallower than the others. On the right lateral, anterior, and superior surfaces of two livers, there were three grooves, fissures, or sulci. No liver had the four grooves, fissures, or sulci that were seen. On the right lateral, anterior, and superior surfaces of two livers, five grooves, fissures, or sulci were seen. The sulci, grooves, fissures, and notches had mean lengths of 3.8 cm, widths of 1.0 cm, and depths of 0.9 cm (0.2cm-3.8cm). The 3.8 cm deep groove was the deepest of all grooves and resembled a deep fissure or notch. The longest groove, out of all grooves, measured 7.5 cm in length, and the widest groove, out of all grooves,

measured 2.3 cm in width. There were 38 grooves, fissures, sulci, and notches in total. The details of liver samples used in study are mentioned in table 1.

Table 1: Showing number of diaphragmatic fissures/grooves/sulci in different liver specimens

The study included 100 livers over all		
Number of diaphragmatic fissures/grooves/sulci	**Number of liver specimens**	**Percentage**
Presence of at least one abnormal groove	18	18%
Presence of one groove	06	06%
Presence of two grooves	08	08%
Presence of three grooves	02	02%
Presence of four grooves	00	00%
Presence of five grooves	02	02%

RESULT AND DISCUSSION

Congenital liver anomalies are primarily caused by faulty liver development or overdevelopment in conjunction with diaphragm abnormality[16]. Some morphological alterations are found during advanced radiological examinations that may be false lesions caused by focal fatty infiltrations or perfusion deficiencies, among other things, rather than actual parenchymatous lesions[17]. Accessory fissures were most commonly detected on the right lobe, followed by the quadrate lobe, the caudate lobe, and extremely rarely on the left lobe [18]. Because of the fluid build-up inside, these fissures, according to Auh and his colleagues, could be misdiagnosed as a liver cyst, liver abscess, or intrahepatic haemorrhage. As these fissures contain tumour cells, they may resemble intrahepatic focal lesions[8]. The right lobe has more diaphragmatic fissures than the left, although they do not extend past the upper section of the liver and are largely visible on the anterosuperior, posterior surface of both lobes[7,19]. They can range in size from one to several, with different dimensions for length, width (wide or narrow), and depth (shallow or deep) [20]. Females older than 15 years are more likely than males to develop diaphragmatic fissures [21]. Several reports also identifies two diaphragmatic fissures apparent as notches on the anterior surface of the liver's right lobe and substantial left lobe. Furthermore, the right liver lobe showed two notches, but the left lobe was normal or lower in size [20,22]. In the current investigation, the right

lobe of the five livers had 06 diaphragmatic fissures apparent as notches on the anterosuperior surface, whereas the left lobe of two livers was large, one liver was tiny, and the other two livers were normal in size. In addition, other reports indicated that the anterosuperior surface possessed up to 6-9 numerous diaphragmatic fissures [19,20]. On the anterosuperior and right lateral surfaces of the liver's right lobe, up to 5 numerous diaphragmatic fissures were found in the current investigation. In addition, diaphragmatic fissures were also seen by Macchi and his team members in 40% of the patients they examined at autopsy, 47% of which had numerous fissures. All of these fissures/sulci were identified on the superior surface of the liver's right lobe [23]. Another report indicates that in 6-7.5% of patients, there may be a significant vertical groove and diaphragmatic sulci[19, 24]. In the current investigation, 38 diaphragmatic fissures were found in eighteen liver specimens, which means that 18% of the liver samples showed vertical grooves, and they were all located on the right lobe of the liver. Diaphragmatic sulci/fissures build up as a result of the liver parenchyma's uneven development in response to either costal pressure or resistance brought on by hypertrophied diaphragmatic muscle bundles. Some studies found that the presence of diaphragm folds did not cause diaphragmatic fissures to form [5]. However, some authors claimed that the diaphragmatic fissures are caused by the fold of the diaphragm [7,25]. Others reported that they developed as a result of respiratory conditions known as cough furrows [26,27,28]. Diaphragmatic sulci have been identified in studies using corrosion cast or radiographic studies due to pre-existing weak zones of liver parenchyma represented by portal fissures [24,29,30]. The diaphragmatic sulci operate as landmarks for the projection of portal fissures and hepatic veins with their tributaries [23,31,32]. The anterosuperior surface and right lateral surface of the right lobe of the liver in the current investigation both have diaphragmatic fissures/sulci, but not the left lobe of the liver, as shown in figure 1.

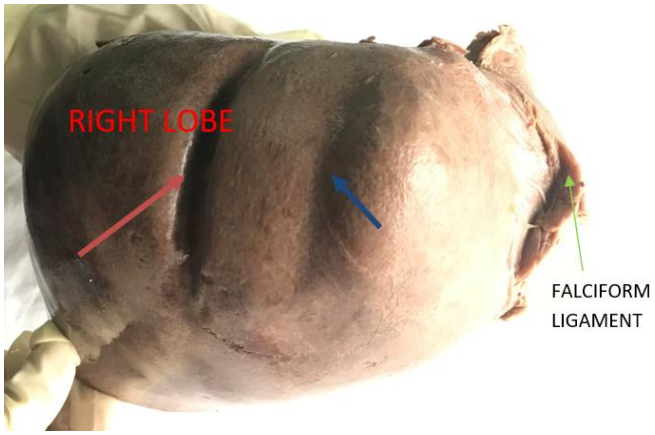

Fig 1A: Illustrating the two supplementary fissures that stretch from the anterior surface to the superior and posterior surfaces in the right lobe of the liver's anterosuperior view. Red arrow shows broad and deep fissure causing notched appearance, blue arrow shows broad but shallow fissure. The portion of the liver in between the two grooves is bulging upward.

Fig 1B: Displaying an enlarged view of the right hepatic lobe with two supplementary fissures extending from the anterior to the superior and posterior surfaces.

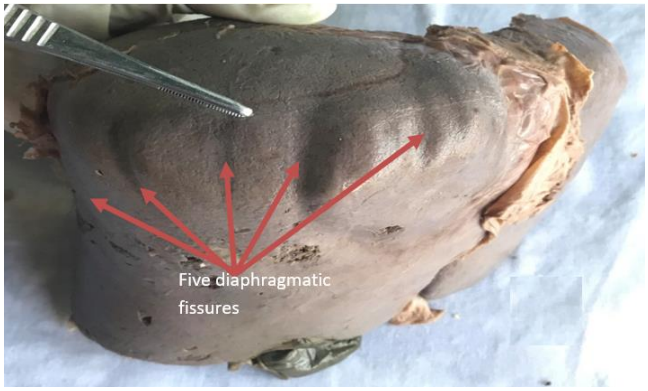

Fig 1C: Demonstrating the right lobe of the liver from the anterior to the superior and posterior surfaces, with five supplementary grooves and diaphragmatic fissures.

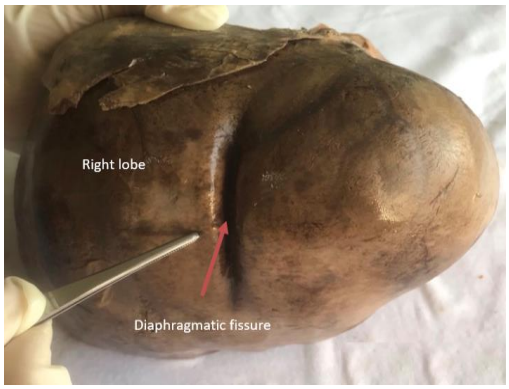

Fig 1D: Right hepatic lobe's auxiliary fissure can be seen in a superior view, spreading from the anterior surface to the superior and posterior surfaces.

Fig 1E: Three accessory fissures can be seen in the right lobe of the liver's anterior-superior view, spanning from the anterior surface to the superior surface and posterior surface.

Figures 1A-E: Representing different views of the liver with accessory fissures

CONCLUSION

There are very few cadaveric studies on the fissures and grooves of the diaphragmatic surface of the liver. As a result, research reports are the only source of information on these fissures and grooves. In the present study, we observed the presence of fissures and grooves on the diaphragmatic surface of the liver and identified the length, breadth, depth, and position of these fissures and grooves in the 100 cadavers. All of the grooves in our study are parallel to one another and to the sagittal plane, therefore they are neither corset-related nor cough furrows. The knowledge of the proper size and location of these grooves/fissures will be used by anatomists, radiologists, surgeons, embryologists, and forensic experts. This information may help radiologists avoid misdiagnosis, assist surgeons in planning surgical procedures like hepatic resections and liver transplant surgeries, and assist forensic experts in conducting post-mortem examinations because these grooves/fissures may mimic abdominal trauma injuries.

REFRENCES

1. Standring, S., Ellis, H., Healy, J., Johnson, D., Williams, A., Collins, P. and Wigley, C., 2005. Gray's anatomy: the anatomical basis of clinical practice. American journal of neuroradiology, 26(10), p.2703.
2. Singh, H.R. and Rabi, S., 2019. Study of morphological variations of liver in human. Translational Research in Anatomy, 14, pp.1-5.
3. Thomson, A., 1899. The morphological significance of certain fissures in the human liver. Journal of Anatomy and Physiology, 33(Pt 4), p.546.
4. Phad, V.V., Syed, S.A. and Joshi, R.A., 2014. Morphological variations of liver. Int J Health Sci Res, 4(9), pp.119-124.
5. Newell, R.L. and Morgan-Jones, R., 1993. Grooves in the superior surface of the liver. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists, 6(6), pp.333-336.
6. Macchi, V., Porzionato, A., Parenti, A., Macchi, C., Newell, R. and De Caro, R., 2005. Main accessory sulcus of the liver. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists, 18(1), pp.39-45.
7. Covanțev, S., Mazuruc, N., Catereniuc, I. and Belic, O., 2018. Accessory liver fissures: a report of two cases and review of their clinical significance. Russian Open Medical Journal, 7(3), p.303.
8. Auh, Y.H., Lim, J.H., Kim, K.W., Lee, D.H., Lee, M.G. and Cho, K.S., 1994. Loculated fluid collections in hepatic fissures and recesses: CT appearance

and potential pitfalls. Radiographics, 14(3), pp.529-540.

9. Ono, M.L., Murakami, G., Sato, T.J. and Sawada, K., 2000. Hepatic grooves and portal segmentation. Kaibogaku zasshi. Journal of Anatomy, 75(6), pp.517-523.
10. Yadav, G.D. and Deka, P., 2008. Accessory sulcus of the liver—an incidental laparotomy finding. Indian Journal of Surgery, 70(2), pp.92-93.
11. Kanchan, T., Acharya, J. and Naik, R., 2014. Grooves on the hepatic surface. Journal of Forensic and Legal Medicine, 21, pp.24-25.
12. Kanchan, T., Acharya, J. and Naik, R., 2014. Grooves on the hepatic surface. Journal of Forensic and Legal Medicine, 21, pp.24-25.
13. Tung, K.T., Wells, A.U., Rubens, M.B., Kirk, J.M., du Bois, R.M. and Hansell, D.M., 1993. Accuracy of the typical computed tomographic appearances of fibrosing alveolitis. Thorax, 48(4), pp.334-338.
14. Nayak, B.S., 2013. A study on the anomalies of liver in the south Indian cadavers. Int J Morphol, 31(2), pp.658-61.
15. Glenisson, M., Salloum, C., Lim, C., Lacaze, L., Malek, A., Enriquez, A., Compagnon, P., Laurent, A. and Azoulay, D., 2014. Accessory liver lobes: anatomical description and clinical implications. Journal of visceral surgery, 151(6), pp.451-455.
16. Daver, G.B., Bakhshi, G.D., Patil, A., Ellur, S., Jain, M. and Daver, N.G., 2005. Bifid liver in a patient with diaphragmatic hernia. Indian Journal of Gastroenterology: Official Journal of the Indian Society of Gastroenterology, 24(1), pp.27-28.
17. Sangeetha, A. and Kumar, S.N., 2021. Morphological variations of the liver and its applied significance: A cadaveric study. Journal of Datta Meghe Institute of Medical Sciences University, 16(2), p.303.
18. Vinnakota, S. and Jayasree, N., 2013. A new insight into the morphology of the human liver: a cadaveric study. International Scholarly Research Notices, 2013.
19. Joshi, S.D., Joshi, S.S. and Athavale, S.A., 2009. Some interesting observations on the surface features of the liver and their clinical implications. Singapore medical journal, 50(7), p.715.
20. Sreekanth, T., 2016. Diaphragmatic fissures and accessory sulci of liver in the population of Telangana. Int J Anat Res, 4(4), pp.3273-79.
21. Gerscovich, E.O., Cronan, M., McGahan, J.P., Jain, K., Jones, C.D. and McDonald, C., 2001. Ultrasonographic evaluation of diaphragmatic motion. Journal of ultrasound in medicine, 20(6), pp.597-604.
22. Prasad, A.M., PAMIDI, N. and GEORGE, B.M., 2012. Notched liver associated with subhepatic caecum and appendix–a case report. Int J Anat Var (IJAV), 5, pp.48-50.
23. Macchi, V., Feltrin, G., Parenti, A. and De Caro, R., 2003. Diaphragmatic sulci

and portal fissures. Journal of anatomy, 202(3), pp.303-308.

24. Chaudhari, H.J., Ravat, M.K., Vaniya, V.H. and Bhedi, A.N., 2017. Morphological study of human liver and its surgical importance. Journal of Clinical and Diagnostic Research: JCDR, 11(6), p.AC09.
25. Ferris, H.B., 1929. Quain's Elements of Anatomy. The Yale Journal of Biology and Medicine, 1(6), p.419.
26. Garancini, M., Gianotti, L., Delitala, A., Romano, F., Degrate, L. and Giardini, V., 2015. Intraoperative ultrasound: a review on its role in liver surgery for primitive and metastatic tumors. Minerva Chirurgica, 71(3), pp.201-213.
27. Dooley, J.S., Lok, A.S., Garcia-Tsao, G. and Pinzani, M. eds., 2018. Sherlock's diseases of the liver and biliary system. John Wiley & Sons.
28. Scadding, J.G., 1966. Clinicopathological Conference. A case of chronic Bronchitis with Macleod's.
29. Patnaik, M., Mohakud, S., Gaikwad, M.R. and Ravi, P.K., 2022. A case of accessory anterior hepatic fissure: Cadaveric study with retrospective radiological investigation into its vascularity. National Journal of Clinical Anatomy, 11(2), p.118.
30. Tsomaia, K., Patarashvili, L., Bebiashvili, I., Azmaiparashvili, E., Kakabadze, M., Jalabadze, N., Sareli, M., Gusev, S. and Kordzaia, D., 2020. New corrosion cast media and its ability for SEM and light microscope investigation. Microscopy Research and Technique, 83(7), pp.778-789.
31. Cawich, S.O., Gardner, M.T., Thomas, D.A., Deshpande, R., Mohammed, F. and Arena, G., 2021. Liver Variant: A Report on Diaphragmatic Slips and Hepatic Sulci. Int J Anat Var Vol, 14(1), p.33
32. Cano-Vicent, A., Tambuwala, M.M., Hassan, S.S., Barh, D., Aljabali, A.A., Birkett, M., Arjunan, A. and Serrano-Aroca, Á., 2021. Fused deposition modelling: Current status, methodology, applications and future prospects. Additive Manufacturing, 47, p.102378.