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Original Research Article

Morphology and morphometry of fissures on the liver surface, an anatomical study based on cadaver dissection

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Abstract

Background: Fissures are seen on various surfaces of liver. Fissures like fissure for ligamentum teres hepatis, fissure for ligamentum venosum, porta hepatis are a regular feature on the visceral surface of liver. Some fissures like fissure of Gan's is seen as a variation. Fissures which are observed as a variation are called as accessory fissures. Fissures on the surface of liver play a crucial role in surgical navigations, radiological interpretations and anatomical studies. A comprehensive evaluation based on morphology and morphometry of these liver fissures has been done in this study.

Materials and Methods: This study was conducted on 30 cadaver liver specimens fixed in 10% formalin. These liver specimens were obtained from human cadavers during routine undergraduate dissection classes. Morphology i.e shape of the fissure, any other associated feature and content at the base of the fissure if present was observed. Morphometry was studied by measuring the length, width and depth of fissures. Measurements were done with the help of a thread, divider and the scale.

Results: The average dimensions of fissure for ligamentum teres hepatis were found to be length 5.1cm, width 4.5mm and depth1.9cm. It was linear and vertically or sometimes obliquely placed. The average dimensions of fissure for ligamentum venosum were found to be length 6.1cm, width 7mm and depth 2.5cm. It was curvilinear and vertically placed. The average circumference of porta hepatis was 10.6cm and it had oval to elliptical silhouette. Amongst the accessory fissures the fissure of Gan's which is also called as Rouviere's sulcus was seen in 76.6% of cases with a curvilinear shape. Apart from fissure of Gan's, there were other accessory fissures seen as a variation on the posterior surface of right lobe liver.

Conclusion: There is paucity of data regarding the morphology and morphometry of the hepatic fissures based on cadaver and imaging studies. These fissures on the surface of liver serve as an important landmark to delineate vascular structures in various surgical procedures and imaging studies. The morphological and morphometric observations will help the surgeons and radiologists during surgical interventions and radiological interpretations on liver.

Keywords: Fissure for ligamentum teres hepatis, Fissure for ligamentum venosum, Porta hepatis, Fissure of Gans, Rouviere's sulcus, Accessory hepatic fissures.

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1. Introduction – Liver is Characterised by Presence of Fissures on Its Various Surfaces (Figure 1)

These fissures are predominantly seen on posterior and visceral surface. There are three major fissures which are not visible on the surface of the liver, there are three minor fissures which are visible on the posterior and visceral surface of the liver[1] and there may be presence of accessory fissures on liver surface which are also visible. This study is carried out on the fissures which are visible on the surface of liver. Fissure for ligamentum teres hepatis, fissure for ligamentum venosum and fissure of porta hepatis are regularly seen on the visceral surface of liver. A deep fissure extends almost vertically across the visceral surface of liver. The upper part of this fissure is fissure for ligamentum venosum and the lower part of this fissure is fissure for ligamentum teres.[2] Fissure for ligamentum venosum is also called as venous fissure and Fissure for ligamentum teres hepatis is also called as umbilical fissure. Near the middle of visceral surface there is a transverse fissure with oval outline, through which the liver ducts and vessels navigate. This fissure is called as porta hepatis (**Figure 1**). There are some fissures which are not a regular feature on the surfaces of liver. They are designated

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as accessory fissures. Fissure of Gans which is an accessory fissure is also documented as Rouviere's sulcus.[1,3] All these fissures play an important role in surgical navigation, radiological interpretations, and anatomical studies. Present study presents a detailed morphological and morphometric analysis of fissures seen on the surface of the liver.

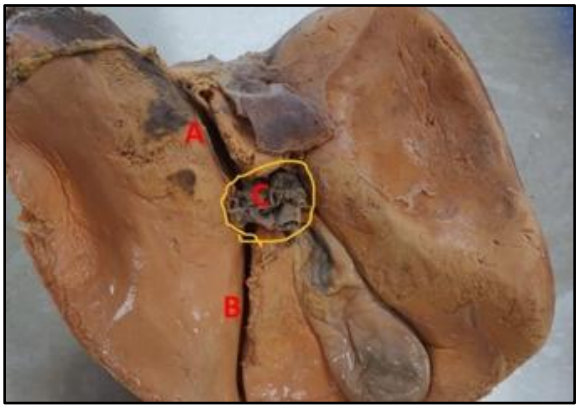

Figure 1: Fissure for ligamentum venosum **(A)** and Fissure for ligamentum teres hepatis **(B)** are vertically placed. Fissure for porta hepatis **(C)** is transversely placed represen ted by yellow line.

2. Objective

To study the morphology (shape, any other associated feature, content of fissure if any) and morphometry (length, width, depth) of fissures seen on the surface of liver.

3. Materials and Methods

This study was conducted on 30 cadaver liver specimens fixed in 10% formalin. The liver specimens were obtained during routine dissection carried out by undergraduate students in the Anatomy dissection hall. Morphology i.e shape of the fissure, any other associated feature and content at the base of the fissure if present was observed. Morphometry was studied by measuring the length, width and depth of fissures. Measurements were done with the help of a thread, divider and the scale. The width of the fissures was measured with the help of a divider and scale at the middle of the fissure. The length of the fissure for ligamentum teres was measured from the inferior border of the liver up to its cranial limit. The length of fissure for ligamentum venosum was measured from its cranial end along the superior surface of the liver up to its caudal limit. The circumference of fissure for porta hepatis was measured with the help of thread. The length and width of accessory fissures was measured with the help of thread, divider and scale.

4. Results

Table 1: Morphology of fissures on the liver surface

Morphologic Parameters	**Fissure**				
	Fissure for ligamentum teres	**Fissure for ligamentum venosum**	**Porta Hepatis**	**Fissure of Gans**	**Any other accessory fissure**
Present/Absent	Present in all 30 liver specimens (100%)	Present in all 30 liver specimens (100%)	Present in all 30 liver specimens (100%)	Present in 23 out of 30 cases (76.6%)	Apart from Fissure of Gans other multiple accessory fissures were seen in 9 (30%) specimens on various hepatic surface
Shape	Curvilinear	Curvilinear, oblique	Oval/ Elliptical	Curvilinear in 18 specimens Thin scar like in 5 specimens	Oblique
Content at the base of the fissure/ Structures passing through the fissure	Present in all 30 specimens (100%)	Present in all 30 specimens (100%)	Present in all 30 specimens	Absent	Absent
Bridge of hepatic tissue over the fissure	Present in 6 specimens (20%)	Absent	Absent	Absent	

Table 2: Morphometry of fissures on liver surface

Morphometric Parameters	**Fissure**				
	Fissure for ligamentum teres (Umbilical fissure)	**Fissure for ligamentum venosum (Venous fissure)**	**Porta Hepatis**	**Fissure of Gans (Rouviere's sulcus)**	**Any other accessory fissure**
Average length/Circumference in cm	5.1cm	6.1cm	10.6cm	3.3cm	3.7 cm
Range of length/circumference	2.8 to 7.4cm	4.2 to 9.5cm	8.5 to 13 cm	0 to 6.5 cm	1.5 to 5.7cm
Average width in mm	4.5 mm	7 mm	-	1mm	1mm
Range of width in mm	1mm to 10mm	7mm to 10mm	-	0 to 3mm	0 to 2mm
Average Depth in cm	1.9cm	2.5 cm	2cm	1mm	1mm
Range of depth in cm	0 to 3.2cm	1.3 to 1.4cm	1.5 to 2 cm		

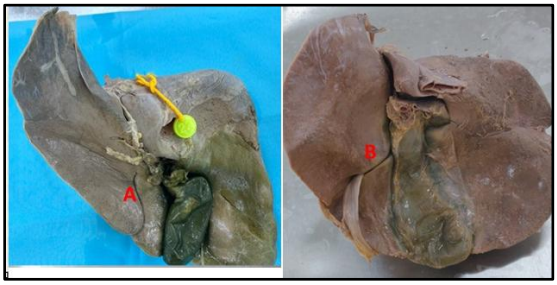

Figure 2: Fissure for ligamentum teres hepatis**. (A)** Vertically placed **(B)** Obliquely placed

Figure 3: Pons hepatis

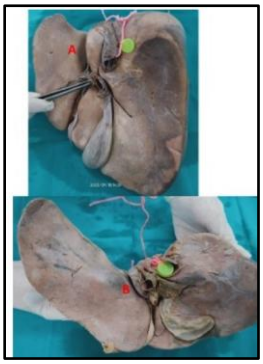

Figure 4: (A) Vertically and **(B)** obliquely placed fissure for ligamentum venosum.

Figure 5: Arrow pointing towards the branch of left hepatic artery in the fissure for ligamentum venosum.

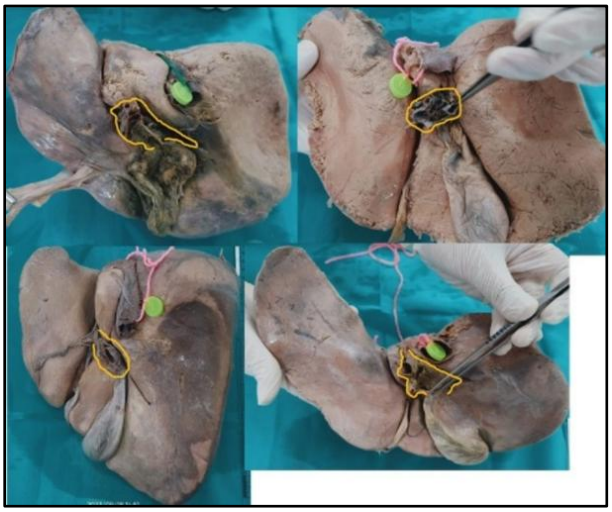

Figure 6: Oval, Elliptical and irregular silhouette of porta hepatis

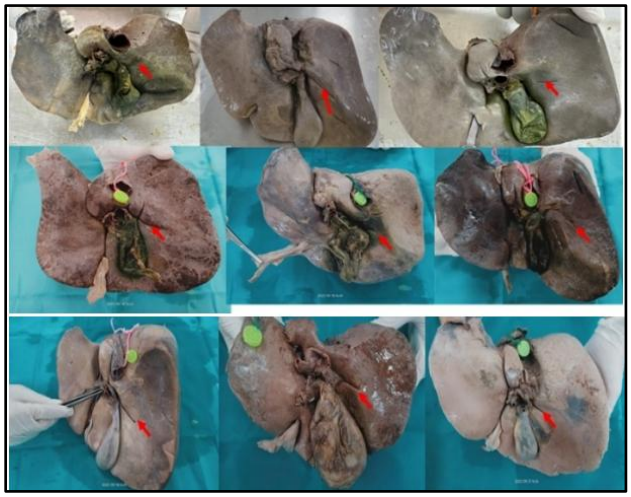

Figure 7: Red arrow pointing towards the fissure of Gan's depicting its variations.

Figure 8*: Arrow pointing towards the accessory fissures on the visceral surface of right lobe of liver.*

4.1. Fissure for ligamentum teres hepatis

This fissure also called as umbilical fissure, was present in all the 30 liver specimens with ligamentum teres hepatis at its base. It is a deep groove which extends from the inferior border of the liver to the left end of porta hepatis. In the present study it was linear in shape and it was placed vertically but quite often obliquely as well (**Table 1**) (**Figure 2**).

Its average dimensions as seen in **Table 2** are 5.1cmX4.5mmx1.9cm. It was bridged by liver tissue (pons hepatis) (**Figure 3**) in 6 specimens i.e. 20% of cases.

The bridging tissue as mentioned in **Table 1** was covering the upper half to upper 3/4th of the fissure in some cases. Hence a very small terminal part of around 1.5 cm was visible in these cases.

4.2. Fissure for ligamentum venosum

This fissure is also called as venous fissure. It is a deep groove which extended between the caudate lobe and left lobe of liver on the visceral surface. In the present study as mentioned in **Table 1** it was present in all the 30 liver specimens with ligamentum venosum and two layers of lesser omentum as its content. It was curvilinear in shape and it was placed vertically but quite often obliquely as well (**Figure 4**). Aberrant branch of left hepatic artery was observed in one specimen as seen in **Figure 5**.

4.3. Porta hepatis

Porta hepatis is a transversely placed fissure between the caudate and quadrate lobe of the liver. It is actually the hilum of the liver through which vessels and ducts of the liver navigate. In the present study porta hepatis which was present in all the specimens. It had oval to elliptical silhouette (**Table 1**) (**Figure 6**).

4.4. Fissure of Gan's (Rouviere's sulcus)

In the present study the fissure of Gan's was seen in 76.6% of cases. The shape of the fissure was mostly curvilinear. When present it extends from the right end of porta hepatis to the posterior surface of right lobe of liver. It is predominantly oblique placed as seen in the present study (**Figure 7**) (**Table 1**).

4.5. Accessory Fissures

In the present study multiple accessory fissures apart from Fissure of Gan's were observed in about 30% of the liver specimens. (**Table 1**) These fissures were predominantly located on the visceral surface of right lobe of liver as seen in **Figure 8**. The average length was about 3.5cm, width was 1mm and depth about 1mm as depicted in **Table 2**.

5. Discussion

5.1. Fissure for ligamentum teres hepatis

This fissure also called as umbilical fissure, is present in all the 30 liver specimens as a deep groove extending from the inferior border of the liver to the left end of porta hepatis. (**Table 1**) It is predominantly curvilinear in shape and obliquely placed. Rarely is it horizontally placed as seen in **Figure 2**, with average dimensions as seen in **Table 2** are 5.1cmX4.5mmx1.9cm.

In the present study pons hepatis is seen in 20% of cases (**Table 1**) (**Figure 3**) which closely resembles with the observations of of Joshi et al[4] and Cawich et al[7] i.e 30% and 33% respectively. However the incidence of porta hepatis in present study is very high as compared to the studies done by Patil et al[5], Dave et al[6] and Heena et al[8], who documented it to be 3.8 to 10%. The Pons Hepatis variation has been extensively studied by other researchers. Pons hepatis may be rarely fibrous but predominantly parenchymatous[7,8] Presence of pons hepatis obscures the fissure and the related

land marks. When present it connects the segment IV in the right lobe of liver to the left lobe of liver. This fact is radiologically and surgically relevant.

5.2. Fissure for ligamentum venosum

This venous fissure is seen as deep groove extending between the caudate lobe and left lobe of liver on the visceral surface, with average dimensions as seen in **Table 2** are 6.1cmX 7mmx 2.5cm. There is no tunnelling observed on this fissure. There is paucity of studies documenting the morphometry of this fissure. This fissure is important in radiological imaging as it serves as an important landmark for identifying left hepatic vein. Aberrant artery variant of left hepatic artery may be seen in this fissure during radiological imaging studies.[9]

Fissure for ligamentum venosum is a significant anatomical landmark during liver surgeries, helping to delineate vascular structures and guide surgical approaches.

5.3. Porta Hepatis

In the present study porta hepatis which is a transversely placed fissure with oval to elliptical silhouette has the average circumference of 10.6cm and depth was about 2cm. This finding concurs with observations done by A Saha et al[10] and Neginhal DD et al[11] on cadaver specimens wherein the circumference was found to be 8.33±1.63 and 10.46 ±1.415 respectively. In the study done by Gupta D et al[12] on cadaver specimens the circumference was found to be 13.61 ± 1.92 which is high as compared to present observations. Certain surgical interventional procedures which are done at porta hepatis require complete dissection along the circumference of porta hepatis where in the knowledge of morphology and morphometry of Porta hepatis becomes essential.

5.4. Fissure of Gan's (Rouviere's sulcus)

It is an accessory fissure of crucial surgical importance in laparoscopic cholecystectomy to avoid trauma to bile duct. It may not be always present. In the present study and the study done by Dahmane et al[13] it is seen in 91.3% and 97% of the cases respectively and it was predominantly obliquely placed. However in the laproscopy observations done by Singh and Prasad et al[14] the fissure of Gans was found to be horizontal in 70% of cases. In the cadaver based studies done by Deepalli et al[16] and Lazarus et al[15] it was horizontal in 50% and 41.33% of cases respectively. The obliquely placed Rouviere's sulcus or fissure of Gans is more easy to locate on laproscopy as compared to the horizontal one. The fissure may be deep and prominent or it may be thin like a scar (**Figure 7**). Its presence serves as a safe landmark for dissection.

5.5. Accessory Fissures

Mostly on the posterior surface of right lobe of liver multiple accessory fissures were observed apart from fissure of Gan's in 30% of the cases in the present study. (**Table 1**) In a study done by YH Auh et al[17] the average incidence of accessory fissures on CT scan is 25%. According to this study by YH Auh et al frequency of incidence of accessory fissures increases with age approaching 70% in the 7th and 8th decade. Depth may equal or exceed 2cm in 1/3rd of cases. Multiple accessory fissures may mimic pathological nodules on CT. When only part of these fissures are seen sonographically they may be interpreted as echogenic lesions.[18,19] Hence sound anatomical knowledge of these accessory fissures is important.

6. Conclusion

A comprehensive knowledge regarding morphology and morphometry of fissures on the surface of liver is important for surgical procedures and imaging studies. The present cadaver-based anatomical study highlights the significant variability in the number, location, and dimensions of these anatomical features. Such variations are of considerable clinical relevance, particularly in the context of liver and gall bladder surgeries and radiological interpretations.

6.1. Limitations of the study

The morphometry done in present study is a study based on cadaver dissection, on a small sample size. Further studies with larger sample sizes and incorporation of imaging correlation may be done to enhance anatomical and clinical knowledge in this area.

7. Ethical No:

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8. Source of Funding

None.

9. Conflict of Interest

None.

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