Original Research Article

Segmental anatomy of liver by hepatic veins

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Abstract

Surgeries of liver have advanced much in the past years and the more advancement in the field has brought surgeries along with more conservative procedures. This has made the need of a thorough knowledge of liver anatomy important. Liver is the largest organ in the abdomen with large blood flow which perform many important functions. It has its own insults in the form of infections, primary tumors and also secondary metastasis. It has a good regenerating capacity. This capacity of regeneration has been made to maximum use by the surgeons. In the past, large part of the liver were removed during procedures for primary liver tumours and the area for regeneration was large. Now more conservative surgeries are possible because the liver is no longer viewed as a solid organ below its capsule. The liver is organized into more clearly defined segments which is having its own inflow and outflow vascular channels and also biliary drainage. The inflow vascular channels are the portal vein and the hepatic artery. The blood drains into the inferior vena cava through the hepatic veins. The product of the liver, the bile, flows through the hepatic ducts and then forms the bile duct outside the liver. Based on this pattern it has been divided into eight vascular segments. With the advent of more non- invasive investigative procedures like ultrasonography and computerised tomography scan have made the cross sectional study on liver very easy. In this study I have made a sincere attempt to study the segmental anatomy of liver using the new radiological methods, ultrasonography and dissection methods.

Key Words: hepatic veins.

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Received Date: 18/04/2018 Revised Date: 12/05/2018 Accepted Date: 20/06/2018
DOI: https://doi.org/10.26611/1001633

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 23 June 2018

INTRODUCTION

The liver is divided into 2 hemi livers by the main hepatic scissura within which runs the middle hepatic vein. The left liver is divided into 2 sectors by the left portal scissura within which the left hepatic vein runs. The posterior sector is comprised of only one segment. The anterior sector is divided by the umbilical fissure into 2 segments, a medial segment **(Quadrate Lobe) (Segment IV)** and a lateral segment **(Segment III)** which is the anterior part of the left lobe. The right liver is divided into 2 sectors by the right portascissura containing the right hepatic vein. Each of these two sectors is divided into 2 segments, an anterior sector (segment V inferiorly and segment VIII superiorly) and a posterior sector (segment VI inferiorly and segment VII superiorly). Segment I (the caudate lobe) lies posteriorly embracing the inferior vena cava, its intra parenchymal anterior surface abutting the posterior surface of segment IV and merging with segment VI and VII on the right.

Collection of specimens: The liver specimens with which the study of segmental anatomy was studied were procured from the Department of anatomy. All the specimens studied were adult specimens. The cause of death was due to reasons other than liver problems. During the harvesting of the liver specimens no gross anomalies were noted. During the harvesting of the specimens the falciform ligament was retained and a long portal pedicle along with the gall bladder was taken. The inferior vena cava was cut at the level little above and below the posterior surface of the liver. This was done to preserve the opening of the hepatic veins into the inferior vena cava. This study of segmental anatomy of liver was conducted in 100 specimens in the following methods.

MATERIAL AND METHODS

1. Cadaveric specimen - 30
2. Radiological method - 20
3. Ultrasound method - 20

Methods of study

During this study of the segmental anatomy of liver the following methods were used

1. Manual dissection method
2. Radiological study by contrast method
3. Ultrasound method

MANUAL DISSECTION METHOD

Cadaveric study: The liver specimens with which the study of segmental anatomy was studied in cadavers which was used in dissection hall for study purposes. The study was done on 30 formalin fixed dissecting room cadavers. The mean age of the cadavers was 60 years (Range 45- 75) with a sex distribution of 20 males and 10 females. An midline incision made in the anterior abdominal wall from the xiphisternumupto the umbilicus. From the lower end of the incision, a transverse incision was made till the mid axillary line. Skin flap was raised and the rectus abdominis were refelected in the same plane. Peritoneum was opened. Liver and stomach were visualized. The liver was released from its attachments. The collected liver specimens were washed thoroughly and dissected under water to see segments along its vascular planes.

Radiological Study by Contrast Method: In this method of study of the segmental anatomy of liver, 20 specimens were studied. The liver got from the Forensic Medicine Department was washed in running water thoroughly to remove all the blood. The hepatic artery and the bile duct were flushed with syringe to remove the blood and excess bile which would help in the flow of the contrast agents. The contrast agent used was urograffin which was injected into the bile duct and the hepatic artery and x rays were taken.

Ultrasound Method – Clinical Study: This was done at the department of Radiology at Stanley Medical College, Chennai. This study was done on 20 patients who had referred for abdominal scan for other reasons other than liver problems. All the patients selected were adult patients. As a routine for abdominal scan the patients were asked to come in empty stomach. Some of the patients were allowed to drink sips of water in order to prevent excessive thirst. The patients were made to lie in supine position for the scan for liver. Before proceeding for the scan, the abdomen was palpated to exclude any enlargement of liver or pain abdomen.

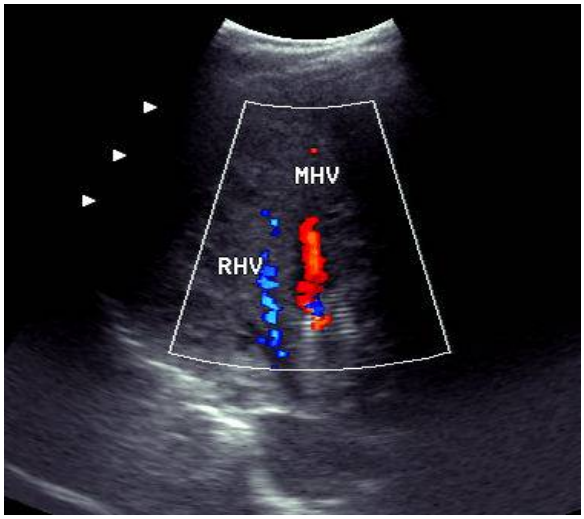

Figure 1:

The probe used for the liver scan had a transducer of 3.5 MHz. This was selected because at this frequency the penetration was good. But the resolution is always low. The scanning was done in sagittal plane, transverse plane, oblique planes. Intercostals and subcostal views were also seen. In this method the hepatic veins and its branching pattern, portal vein and its branching and bile ducts were observed.

OBSERVATIONS AND RESULTS

Table 1:

Sr. No.	Various pattern observed	Number of specimens	Percentage %
1	Right hepatic vein is larger than the middle and left hepatic veins	80	100%
2	Middle hepatic vein observed to join the left hepatic vein	70	87%
3	A single vein was seen draining the caudate lobe of the liver	80	100%

The study of the segmental anatomy of liver and its clinical importance done at the Department of Anatomy, Madha Medical College, is based upon the hepatic veins which divided the liver into lobes. In this study the manual dissection method was used to observe the branching pattern of hepatic veins. In the radiological method the urograffin contrast agent was used to study the segmental branching pattern of hepatic artery and the hepatic duct. In the ultrasound method which was the easiest to perform and great deal of information was available in short time. In the ultrasound method the segments of the liver were studied and the findings correlated with the finding of the manual dissection and

radiological methods. The findings observed are given below

Hepatic Veins: All the three major hepatic vein were observed in the manual dissection method as well as the ultrasound method. In the manual dissection all the hepatic veins were traced from the inferior vena cava where their orifices were seen, into the liver substances. In the ultrasound method the veins were observed joining the inferior vena cava. The hepatic veins right, left and the middle were seen well in the transverse view with the section very near the diaphragm with the transducer at a slightly Cephalad Angulation. The right hepatic vein was observed to be larger than the left and middle hepatic veins**.** The middle hepatic vein observed to join the left hepatic vein in 80 specimens. The middle hepatic veins was seen to be present along the Rex cantlie line thus dividing the liver into two equal halves. A single vein along with small veins was seen draining the caudate lobe in all dissection specimens studied shows its independent drainage. There were no accessory veins observed in this study.

DISCUSSION

Lobes Of Liver: Previously, the division of the lobes was conventionally done by surface marking and topographical relation of the organ, until first it was divided into right and left lobes based on the branching of hepatic artery (Cantlie 1888), based on hepatic ducts (Hjorstojo, 1948). The importance of the Rex – Cantlie plane was then recongnized by Ton That Thug in 1939 which was the principal plane that divided the liver into right and left hemi livers. This is a plane passing through the gallbladder bed towards the inferior vena cava and passes through the right axis of the caudate lobe, the middle hepatic vein lies in this plane. In this study it was observed that the midde hepatic vein was present in the principal scissura which corresponded to the Rex – Cantlie line in all the specimens studied thus establishing the importance of this plane.

Segments of Liver: The importance of more conservative surgery and need for limited resection of liver lead to establish the segmental anatomy of liver where the liver is divided into still smaller functional segments than just lobes. After the establishment of the major vascular territories of arteries and hepatic venous supply Hjorstojo, 1948,[1] the traditional method of division of the hepatic segments based on the topographical relation of the liver was dropped and classification based on the vasculature of liver started. In the American system, the liver was divided into four lobes and the importance of the caudate lobe was not considered here but this formed the basis of the four classical types of hepatic resection. In the French system (Couinaud, 1953)[2]there are 8 segments and the caudate lobe is considered as imdependent lobe and this gained popularity and it is now globally accepted by surgeon of the two system of classification of segmental anatomy of liver that are present. Claude deCouinaud a French surgeon and anatomist proposed the new segmental anatomy of liver. He divided the liver into 8 segments. He described that the right lobe is divided into two sectors namely anteromedial and posterolateral. The anteromedial sector was divided into segment V anterior and segment VIII posterior. The posterolateral sector was divided into segment VI anterior and segment VII posterior. He divided the left lobe into three segments and named them segment II posterior and segment III anterior and segment IV medial to umbilical fissure. The Spigelian lobe or the caudate lobe or the segment I is considered as an autonomous segment. In this study, all the specimens studied were found to have 8 segments that corresponded to the Couinaud segments.

Hepatic Veins: With the establishment of relationships between the portal venous system and hepatic venous systems, (Glisson 1659)[3]the nomenclature for major branching of intrahepatic portal vein and for major hepatic veins (Rex 1888).

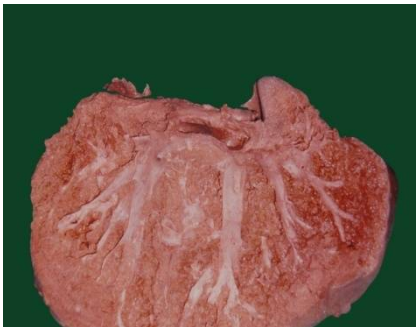

Figure 2:

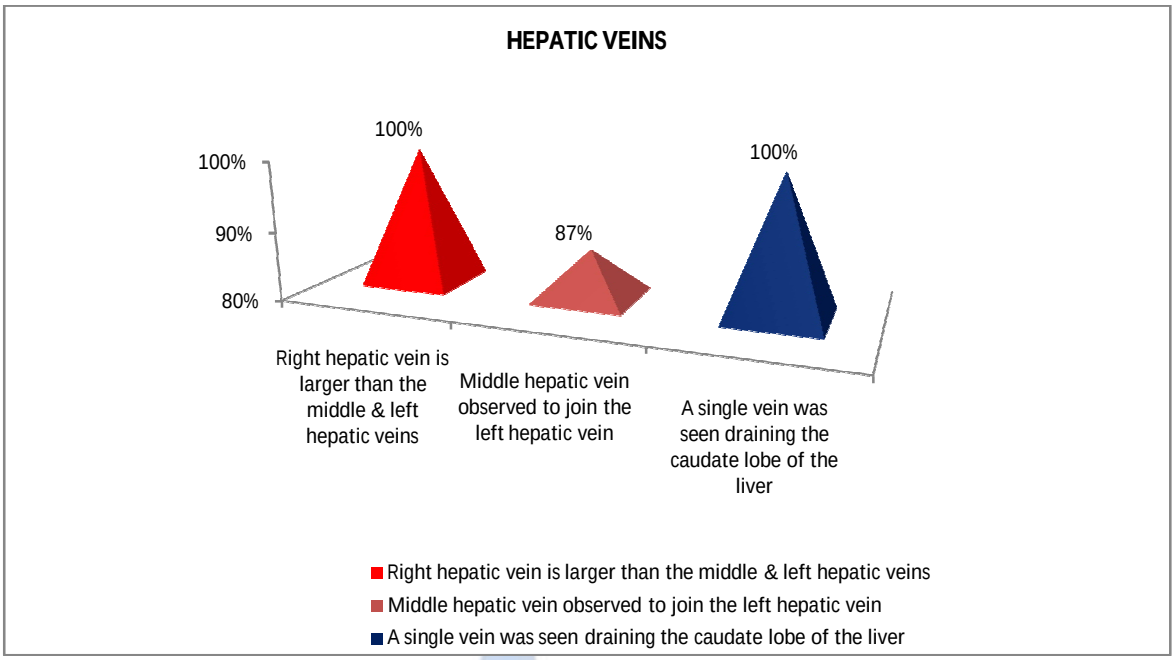

Figure 2:

Couinaud description of the segments was based upon the division of liver into eight segments following the distribution of the portal pedicles and the location of three hepatic veins. He had put forward that the middle hepatic vein separates the whole liver into right and left lobe. The right hepatic vein further separates the right liver into right posterior sector and right anterior sector and left hepatic vein separates the left liver into the left anterior sector and left posterior sector. In the drainage of hepatic veins observed, in 75% of specimens the left hepatic vein joining with the middle hepatic vein to empty into the inferior vena cava (H. Bismuth)[4]. L. H. Blumgart[5] in his description says that the hepatic veins drain directly from the upper part of the posterior surface of the liver at some what oblique angle directly into the inferior vena cava. The right hepatic vein some what larger than the left vein. The middle hepatic veins has short extra hepatic course. The left and middle hepatic veins may drain separately into the inferior vena cava but frequently joined after a short extra hepatic course to form a common venous channel. He also describes that there are also other short hepatic veins that drain into the inferior vana cava. Peter I Williams (38th edition)[6]Grays anatomy states that there are three hepatic veins drain into inferior vena cava. The most commonly the middle hepatic vein joining with the left hepatic vein. In a majority of cases, the diameters of the right and left hepatic veins were between 7 mm and 13 mm. No gender differences were found in the study by Sharma D Deshmukh A, Rains VK (2001)[7] and they have observed that in 96 % of cases the middle and left hepatic veins form a common trunk. Variations in the drainage pattern of hepatic veins have been reported from time to time. These include accessory right hepatic veins, (Van Leewwen *et al.*, 1994, De Cecchis *et al,* 2000)[8] significant accessory hepatic veins (Marcos *et al.*, 2000)[9] and accessory suprahepatic veins (Bach *et al* 1994-95)[10]. The knowledge of this accessory vein is important for the operating surgeon. In the present study the right hepatic vein, left hepatic vein and the middle hepatic vein were seen in all the specimens, and in 51 0f 58 specimens studied the middle hepatic vein was seen joining with the left hepatic vein. This coincides with the observations of (H. Bismuth and Peter I Williams)[11] there were no accessory veins observed

SUMMARY

The need for more limited resection of the liver has prompted the researchers to look closer into the segmental anatomy of the liver and find more about this organ and about the anomalies that can spring surprises. In this study the hepatic vasculature was studied first, as this forms the basis of the segmental pattern of the liver and also the functional anatomy. In this study the three major hepatic veins, the right hepatic vein, left hepatic vein and the middle hepatic vein were observed in all the specimen. In 87 % of observation the middle hepatic vein joined with the left hepatic vein and formed a common trunk before draining into the inferior vena cava. A single vein was seen draining the caudate lobe the liver.

No variations was seen in the hepatic artery pattern of segmental branching. Triple confluence of the hepatic ducts was seen in one specimen. All the segments were

seen in all the 80 liver specimens observed. This observations on the segmental anatomy of the liver and its variations has great importance to the opening surgeon because a neat surgery is the gateway to successful results. In the past decades, lobotomies were regularly performed, where a large amount of liver tissue was sacrificed for a small tumor present and the results were poor. With more conservative surgeries the segmental pattern of the liver becomes important. The variations at this segmental level should be kept in mind to avoid disastrous results.

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2. In the French system (Couinaud, 1953)[2]there are 8 segments and the caudate lobe is considered
3. (Glisson 1659)[3]the nomenclature for major branching of intrahepatic portal vein and for major hepatic veins (Rex 1888).
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Source of Support: None Declared
Conflict of Interest: None Declared