International Journal of Bioassays
ISSN: 2278-778X
www.ijbio.com

Research Article

STUDY OF VASCULAR SEGMENTS OF LIVER IN DISSECTED CADAVERIC LIVER SPECIMEN

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Received for publication: June 12, 2013; **Revised:** June 27 2013; **Accepted:** September 05, 2013

Abstract: Liver surgeries are common in western world. The details are available both by imaging techniques as well as liver surgeries. The transplantation and resection of liver are in their initial stages in India. So, such data is not available in Indian population. Individual variations in morphology of vessels exist. Knowledge of vessels will define the segments of liver. It helps to plan the plane of resection for surgeries helping in conservation of normal tissue. Palliative embolisation of portal vein feeding the affected segment may provide some relief to the patient. Study of pattern of hepatic vessels by dissection tells about different arrangements and range of dimensions of these vessels to define segments and their respectability prior to surgery. During surgery if cranial hepatic vein is small, it warn us of the larger caudal vein, which warrants extra precautions during surgery. The diameter of inferior vena cava, hepatic veins and their common trunk decide the course of surgery during transplantation[2]. The study was planned to study the vascular segments of the liver specimen without any liver pathology obtained by cadaveric dissection. Study includes morphologic and biometric study of its major vessels.

Keywords: Hepatic Vein, Inferior Vena Cava, Portal Vein, Segment.

INTRODUCTION

The traditional right and left lobe of the anatomist does not reflect the liver's internal vascular or biliary subdivisions which are of considerable surgical importance. With the recent development in surgery especially the liver transplantation and the introduction of powerful image methods which can be used before and during operation. It has become vital to understand vascular and biliary territories which can be isolated as unit for partial hepatectomy and other surgical interventions. These patterns have been established over the last century by classic studies on the liver's vascular and biliary duct branching pattern by dissection, injection and corrosion cast.

Hepatic surgeries are catastrophic due to torrential bleeding and fragile liver tissue. Disposition of hepatic veins and their tributaries is a reliable guide but vary from person to person. These veins do not follow a fixed pattern. Surgical hepatic resection requires preoperative mapping of vessels with portal venography, Computerized tomography (CT scan) and Magnetic resonance Imaging (MRI).The segmental vessels are regular in origin but are variable in number and caliber. The pattern of these vessels is unique for every individual. This makes it necessary to map out the vessels preoperatively and even use of non-invasive imaging methods during surgery (subsegmental, segmental, lobar or extended right lobar resection).

The vascular and biliary territories are important to the demarcation of hepatic segmental and lobar anatomy because of the variation in normal lobar size and configuration. One lobe or segment is often small, with compensatory hypertrophy of the remainder of liver, markedly altering the position of the inter segmental and lobar planes. In addition hepatic masses often enlarge the involved segment or lobe, there by displacing adjacent vascular structures. Moreover cirrhosis alters the normal layout. It helps to differentiate; whether cirrhosis is generalised or localised? If localised, which particular area of liver is affected? Individual variations require imaging to define segmental patterns before operation.

MATERIAL AND METHODS

The study was conducted in the Department of Anatomy at Seth GS Medical College and KEM Hospital, Parel, Mumbai-12. It was an observational study. Grossly normal cadaveric livers were obtained from cadavers preserved by embalming them in 10% formalin for routine undergraduate dissection. The livers dissected as a specimen after 'Abdomen dissection' was obtained with prior permission of Head of the Department. The liver was dissected and removed from its location by cutting all the peritoneal attachments. 50 liver specimen free from any gross evidence of cirrhosis, abscess, primary and secondary malignancy were included in the study. These were stored in 50% formalin. The container used was sufficient to avoid mechanical damage to the liver specimen.

Dissection of cadaveric liver:

The finger fracture technique suggested for liver dissection during surgery is used. Each liver is dissected into four sectors by dividing the liver tissue by finger

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dissection along the plane of three major hepatic veins. The blunt end of knife was used to tease away the liver parenchyma and expose vessels. The middle hepatic vein (MHV) lies along cantile's plane. So, the vessels can be exposed if the parenchyma is dissected along the plane passing from the left side of Inferior Vena Cava (IVC) to the middle of gall bladder fossa. This plane separates right lobe from the left. The vessel was traced from its confluence into the IVC further to show its tributaries. The liver tissue was teased away to expose it.

Right hepatic vein (RHV) lies along right scissura, which divide the right lobe into anterior and posterior segments. The left hepatic vein (LHV) lies within the left lobe; occupies and forms the left intersegmental plane. It is first traced from its confluence into the IVC. The caudal part of the plane is demarcated by umbilical fissure containing the left portal vein (LPV). This plane divides the medial segment from the lateral segment of left lobe. These veins occasionally unite before they terminate into IVC exhibiting various patterns. The diameter is measured within 1cm of their confluence into the IVC. The diameter of IVC is measured in the infra diaphragmatic part at the superior surface of the liver.

Dividing the liver along the planes of portal vein and its branches offers further dissection of liver into segments. The main portal vein enters the liver substance at the porta hepatis. It divides into right and left portal veins. These branches are seen when the connective tissue and the lymph nodes at the porta hepatis are removed. The right portal vein traverses to the right and divides into anterior and posterior segmental branches. Occasionally they are direct branches of the main portal vein. These are dissected by teasing away the hepatic tissue by blunt end of knife.

The diameter of the vessels was measured using the divider and scale, as in fig 1 and 2. The vessel is cut at its formation. The diameter is measured along two planes perpendicular to each other and their mean is taken. The external diameter was measured in 50 where as the internal diameter was measured in only 20 livers. As these intersegmental fissures are dissected, the caudate lobe is separated from rest of the liver tissue along its boundaries.

Fig.1: Measurement of internal diameter

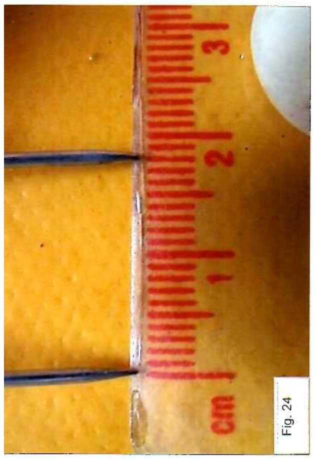

Fig.2: Measurement

Disposal of dissected liver:

The dissected specimens were preserved in 50% formalin solution. With due respect to the biological specimens the livers were disposed off by cremation at the Panvel centre.

Analysis of data:

Data was analyzed by using statistical tests: mean and standard deviation.

Ethics committee approval:

The study was carried out after the approval of Institutional ethics committee.

DISCUSSION

Liver Anatomy:

The liver is a vital and complex gland, with a wide range of functions, including detoxification, protein synthesis, and production of biochemicals necessary for digestion. It has two distinct descriptions, according to its morphological and functional aspects. Morphologically the liver presents 4 lobes: left, right, caudate and quadrate. Functionally the liver present a different anatomy, and one of the proposed ones is the Couinaud model, which is used within this work. The functional anatomy model of Couinaud proposes the division of the liver into eight different regions according to the portal and hepatic veins positions:

As illustrated in figure 3, each segment has its limits defined by the hepatic veins and the portal vein, except segment I, which is drained by the IVC.

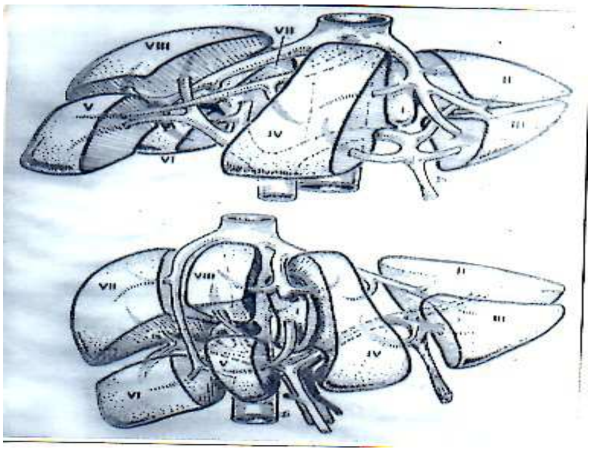

Fig.3: Vascular Segments of liver

Segment I - caudate / Spiegel lobe
Segment II - left posterolateral
Segment III - left anterolateral
Segment IVa - left superomedial
Segment IVb - left inferomedial
Segment V - right anteroinferior
Segment VI - right posteroinferior
Segment VII - right posterosuperior
Segment VIII - right anterosuperior

The observations of the study indicate that the internal architecture of the liver varies. The portal vein branches feed the segments whereas hepatic veins lie in the intersegmental plane. The number of segments is consistent i.e. eight. To equate the segments described with their differing names and the limitations, quoted by all the investigators would not improve the reliability of the information towards its practical application. Because it is the vessels defining the segments, whose morphology and biometry matters during imaging and surgery.

Portal veins form pedicle for each liver segment. Branching of portal vein begin at porta hepatis. Main portal vein divide usually (88-92% of times) divide into right and left portal vein. They further ramify as Segmental and sub-segmental branches. Each of these subsegmental branches lies centrally in respective segment. Right portal vein (RPV) ramifies into anterior and posterior branches. Anterior branch of RPV feed anterior segment whereas posterior branch of RPV feed posterior segment of right lobe.[3, 4]

Table.1: Patterns of division of main portal vein

Pattern of division	Present study		Gupta et al., (1977)	
	Cases	percentage	Cases	percentage
Right and left portal vein	46/50	92	75/85	88
Left branch of portal vein and anterior and posterior segmental vein	4/50	8	10/85	12

Right portal vein is absent if portal vein directly divide into segmental veins**.** In figure 4 shows main portal vein branching into subsegmental branches; superior and inferior branch of anterior trunk and posterior trunk (branches of right portal vein).

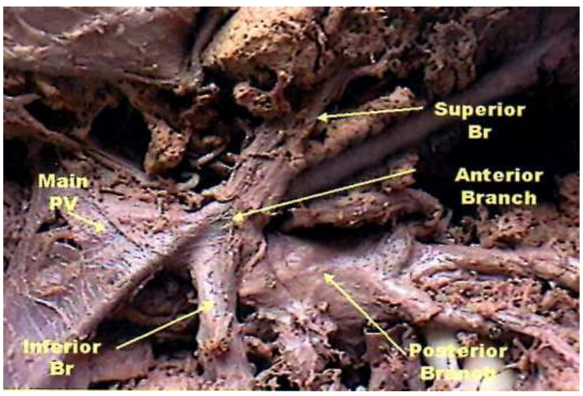

Fig.4: Main portal vein dividing into subsegmental branches

Left portal vein (LPV) gives horizontal and ascending segments. Horizontal segment of LPV lie anterior to caudate lobe separating caudate lobe posteriorly from medial segment of left lobe anteriorly. Ascending segment of LPV divides medial from lateral segment of left lobe.

The internal diameter will decide the type of anastomosis between donor and recipient segments. As a pre-operative procedure of embolisation; the specific portal vein branch feeding diseased segment is blocked. It has less mortality and is suitable in debilitated and terminally ill patients. Architectural pattern and diameter of these vessels will help the surgeon to plan the operative procedure.

Table.2: Measurements of diameter:

Vessel	External diameter in mm (50 cases)	Internal diameter in mm (20 cases)
Main portal vein	16.44± 2.43	14.60 ± 2.53
Right portal vein	8.7± 2.13	7.32 ± 1.32
Left portal vein	7.6 ±1.26	6.67 ± 1.31
Inferior vena cava	21.61± 1.82	20.30 ± 1.48
Right hepatic vein	7.7 ±1.06	6.78 ± 0.92
Left hepatic vein	7.5 ±0.91	6.87 ± 1
Middle hepatic vein	7.6 ±0.99	6.83 ± 0.91

Table.3: Various patterns of drainage of three major hepatic veins and their radicle into the IVC

Sr No	Mode of termination	Present study		Gupta et al., (1979)	
		Cases out of 50	Incidence (%)	Cases out of 95	Incidence (%)
1.	Separate opening of LHV*, MHV+, and RHV**	31	66	10	10.53
2.	Left common trunk formed by union of LHV and MHVs, separate opening of RHV	9	18	60	63.16
3.	Left common trunk formed by union of superior and inferior radicals of LHV and MHVs, separate opening of RHV	Nil	Nil	6	6.32
4.	Separate opening of superior and inferior radicals of LHV, MHV, and RHV	Nil	Nil	5	5.26
5.	Separate opening of right and left radicals of MHV,RHV and LHV	5	10	6	6.32
6.	Left radical of MHV joins with LHV to drain into IVC; Separate openings of right radicle of MHV and RHV	Nil	Nil	1	1.05
7.	Left common trunk formed by union of right and left radical of MHV and LHV; separate opening of RHV	4	8	Nil	Nil
8.	Separate opening for RHV, MHV, LHV and left superior vein	Nil	Nil	Nil	Nil
9.	Left common trunk formed by union of right and left radical of MHV and inferior radical of LHV; Separate opening for RHV and superior radical of LHV	1	2%	Nil	Nil
10.	Single common trunk formed by union of LHV, MHV, and RHV	Nil	Nil	4	4.21
11.	Right common trunk formed by union of RHV and MHV; separate opening of LHV	Nil	Nil	3	3.15
12	Right common trunk formed by union of RHV and right radical of MHV Separate opening for left hepatic vein and left radicle of MHV	1	2	Nil	Nil

Where *=Left hepatic vein, +=Middle hepatic vein, **= Right hepatic vein

RHV runs along the intersegmental plane between anterior and posterior segments. When it is small in caliber, a dorsal hepatic vein will be relatively large. MHV runs along cantlie's line and drains right and left medial segments. It is formed by union of right and left radicals. But variations noted in the present study are not uncommon. LHV runs in left lateral segment. Two main tributaries of LHV are left superior and left inferior radicals.[5, 6]

Various patterns of drainage of three major hepatic veins and their radical into the IVC was noted and classified according to classification suggested by Gupta et al, 1977. The three hepatic veins along with their tributaries are seen in figure 5 and 6.

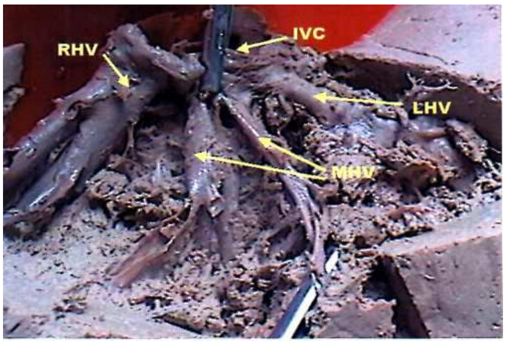

Fig.5: IVC and three hepatic veins

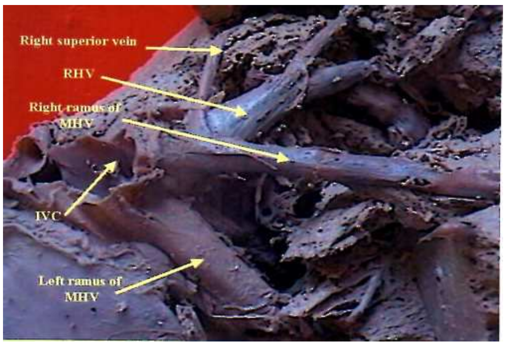

Fig.6: Tributaries of right and middle hepatic vein

Table.4: Morphology of common trunk

Type	Morphologic criteria	Percentage	
		Present Study	Wind et al., (1999)
I	No branch less than 1cm from the entry of common trunk into the IVC. No branch emptying directly into IVC	4	32.81
II	One or more branches in <1cm from the ostium of common trunk except the branches opening directly into the IVC	16	43.78
III	One or more branches emptying into IVC whatever the morphology of the common trunk	10	7.81
IV	No common trunk, MHV and LHV terminate separately into IVC	62	15.63

Table.5: Ramification within 1 cm from IVC

Vessel	No of ramifications cases (percentage)				The vessel itself is absent	
	3	2	1	Zero	Present study	Gupta et al (1979)
RHV	Nil	1(2%)	5(10%)	44(88%)	Nil	Nil
LHV	1(2%)	4(8%)	5(10%)	40(80%)	Nil	11/95(11.5%)
MHV	Nil	5(10%)	1(2%)	34(68%)	10(20%)	7/95(7.3%)

MHV and LHV join before they terminate into IVC are called as common trunk. The length of common trunk (from IVC till its forming tributaries) and diameter are important parameters in the reconstruction of veins after lobectomy or partial resection or transplantation.[7]

Disposition of the hepatic vessels is different for different individual. Modern imaging techniques by providing patient specific details of internal architecture help to decide preoperatively the best treatment options. Radiologic studies of the portal venous system include colour Doppler ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI), and arterial or direct portography are pre-operative methods in practise.[8] Portal vein embolisation and laparoscopic approach to liver are possible because of these technical advances.

Taking into account the frequency of variation, both portal vein ligation and embolisation have proved valuable. They help to conserve liver tissue both as a procedure itself and as a preoperative preparation for resection. These variants must be diagnosed before complex hepatectomy, split or living donor transplantation, and before complex interventional procedures such as portal vein embolization or ligation.[9, 10]

CONCLUSION

Thus we can get hands on experience with dissection of liver for complicated liver surgeries. In this study the livers are dissected from their in situ position. This has enabled study of all the major vessels but same has limited the hands on experience. CT scan of cadaver followed by liver dissection in situ will mimic the actual challenge and impart efficiency.

ACKNOWLEDGEMENT

The present article is part of dissertation submitted for the degree of M.S. (Anatomy) of the University of Mumbai. I would like to express my sincere gratitude to my respected Guide and Institution.

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Source of support: Nil
Conflict of interest: None Declared