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Research article

STUDY OF VASCULAR SEGMENTS OF LIVER ON COMPUTERISED TOMOGRAPHY IN SUBJECTS WITH NORMAL LIVER

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ABSTRACT

Liver, the largest gland in the body receives total perfusion of 1500ml per min even in inactive state. The introduction of Computerised Tomography has made imaging of liver more detailed and safe. The liver is divided into eight vascular segments. Each of them receives a portal pedicle. The ramifications of hepatic veins define intersegmental planes. **Aims:** Pattern of ramification of both portal and hepatic veins, internal diameter of these vessels and their angulation is measured. **Methods and Material:** CT scans of 50 adult patients both male and female for indications other than liver pathology and clinically normal liver were included in the study. **Results:** Portal vein divides into three branches, namely Left branch of portal vein, anterior and posterior segmental vein; branches of right portal vein in 12% of cases. Patterns of drainage of hepatic veins indicate variable internal architecture. Internal diameter of vessels and ramification within 1 cm from IVC determine surgical plan. **Conclusions:** Pattern of internal architecture is unique for each individual. Preoperative CT scan will help to plan resection along the intersegmental plane with minimal loss of liver tissue. The liver transplantation is done using cadaver donor or partial transplantation using live donor. In trauma and malignancy, the affected lobe and segments of liver can be resected preserving the rest, which can hypertrophy to compensate for the loss.

Keywords: Hepatic vein, Portal vein, Liver, Vascular segments

INTRODUCTION

Prior to World War II, mortality due to liver injury was approximately 60%. The initial attempts to control bleeding were by using gauze packs which was later replaced by omentum as living pack. The description of segmental anatomy by Cauniud in 1957 changed the view. [1] This knowledge was used during liver surgeries for trauma to achieve vascular occlusion.

Stephens et al have studied 600 liver examinations by CT scan and stated the consistent findings.[2] The best pictures are obtained within 20-40 EMI units' range of attenuation values. [3]He has defined the segments on basis of boundaries formed by intrahepatic branches of portal vein and hepatic vein. Nagasue et al have beautifully developed the technique of segmental and subsegmental resection in 1985. Anatomic hepatic lobectomy or major segmentectomy involve teasing away of liver tissue to expose vessels. The nomenclature of these resections is based on anatomical description of Cauniaud.[1]

Initially invasive techniques were used to study internal architecture of liver.[4] Liver surgeries have become more common as incidence of liver Ca is raising. The transplantation and resection are now performed in Indian institutions as well. The contrast CT gives accurate dimensions of the intrahepatic vessels, which define the segments. They also define planes for segmental or lobar dissection of liver. In western countries data is available both by CT scan imaging and actual liver dissection during surgeries.[5]Since live liver donation and transplantation are not the routine procedures in India such data is not available in Indian population. [6]

This study was planned to find the normal pattern and variation of hepatic vessels that define the surgical plane. The study will be helpful to derive the normative dimensions of these vessels in Indian population. Yet the branching pattern is unique for each individual. Recent advances in catheterisation of hepatic veins to determine the hepatic blood flow, hepatic venography, panhepatography and increasing interest in hepatic surgery necessitates a detailed knowledge of the pattern of the hepatic vessels.

MATERIAL AND METHODS

Ethics: The Institution is a tertiary care centre with state of art facilities in the Radiology department.

The study was done after the permission of Institutional Ethical Committee.

CT scans of 50 adult patients both male and female for indications other than liver pathology and clinically normal liver were included in the study. The data archived in the CT section of Radiology department at Seth G S Medical College and KEM Hospital, Mumbai during 1/08/2003 to 31/01/2004 was studied. The livers were examined in contiguous slices (8-10 mm). The following measurements taken were on different levels of cross section:

1. A high section through the liver body, which demonstrated dome of right lobe surrounded by lung:
   a. the diameter of right , middle and left hepatic veins.
   b. the diameter of Inferior vena cava.
   c. Angle between hepatic veins.
2. Section through the main body liver: the diameter of right and left portal veins.
3. Section at lower level: the diameter of main portal vein.

Statistics: The data was analysed by using statistical tests of mean and standard deviation.

RESULT

Table 1: Patterns of division of main portal vein

Pattern of division	Present study		Gupta et al (1977)	
	Cases	%	Cases	percentage
Right and left portal vein	42/50	84	75/85	88
Left branch of portal vein and anterior and posterior segmental vein	8/50	16	10/85	12

Right portal vein is absent if portal vein directly divide into segmental veins**.**

Table 2. Measurements of diameter

Vessel	Internal diameter (mm)
Main portal vein	18.48 ± 0.47
Right portal vein	9.87 ± 0.20
Left portal vein	9.33 ± 0.19
Inferior vena cava	27.74 ± 0.53
Right hepatic vein	6.65 ± 0.24
Left hepatic vein	6.82 ± 0.21
Middle hepatic vein	6.22 ± 0.37
Common trunk	13.95 ± 4.96

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

Mode of termination	Present study		Gupta et al (1979)	
	Cases out of 50	Incidence (%)	Cases out of 95	Incidence (%)
Separate opening of LHV*, MHV+, and RHV**	27	54%	10	10.53
Left common trunk formed by union of LHV and MHVs, separate opening of RHV	14	28%	60	63.16
Left common trunk formed by union of superior and inferior radicals of LHV and MHVs, separate opening of RHV	2	4%	6	6.32
Separate opening of superior and inferior radicals of LHV, MHV, and RHV	2	4%	5	5.26
Separate opening of right and left radicals of MHV,RHV and LHV	1	2%	6	6.32
Left radical of MHV joins with LHV to drain into IVC; Separate openings of right radicle of MHV and RHV	1	2%	1	1.05
Left common trunk formed by union of right and left radical of MHV and LHV; separate opening of RHV	1	2%	Nil	Nil
Separate opening for RHV, MHV, LHV and left superior vein	1	2%	Nil	Nil
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
Single common trunk formed by union of LHV, MHV, and RHV	Nil	Nil	4	4.21
Right common trunk formed by union of RHV and MHV; separate opening of LHV	Nil	Nil	3	3.15

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

Table 4: Morphology of common trunk

Type [8]	Percentage	
	Present Study	Wind et al (1999)
I	24	32.81
II	10	43.78
III	6	7.81
IV	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	1(2%)	3(6%)	6(12%)	40(80%)	Nil	Nil
LHV	2(4%)	3(6%)	7(14%)	33(66%)	5/50(10%)	11/95(11.5%)
MHV	5(10%)	8(16%)	1(2%)	33(66%)	3/50(6%)	7/95(7.3%)

RHV= Right Hepatic Vein; [LHV] =Left Hepatic Vein; [MHV] =Middle Hepatic Vein

Table 6. Angle between major radicals of hepatic veins

Between	Angle
RHV &LHV	103.13 ± 30.82
RHV &MHV	48.59 ± 22.36
LHV &MHV	70.78 ± 29.27

RHV= Right Hepatic Vein; [LHV] =Left Hepatic Vein; [MHV] =Middle Hepatic Vein

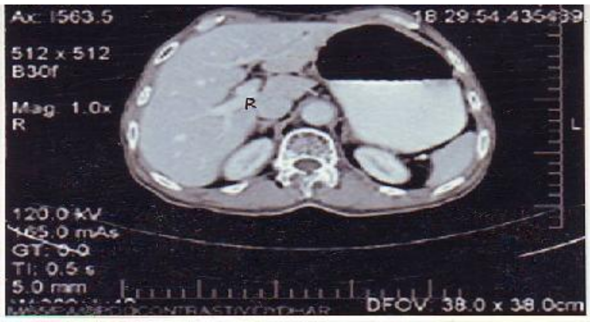

Fig.1: R- Right portal vein

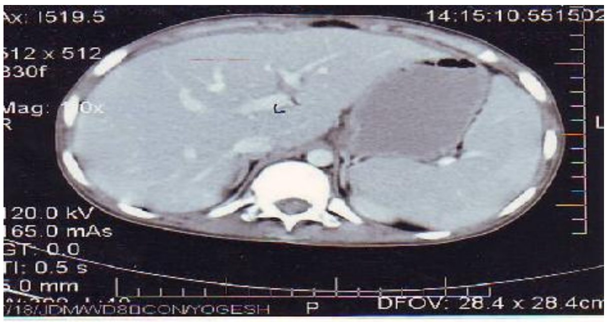

Fig. 2: L-Left portal vein

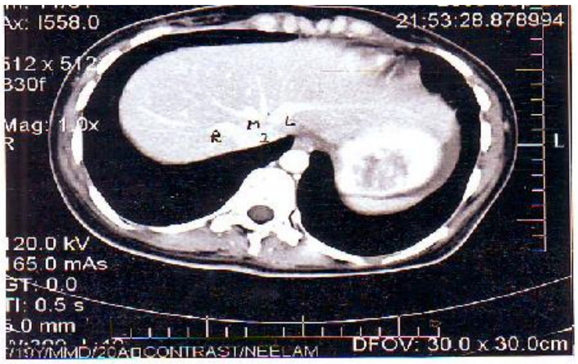

Fig. 3: Three hepatic veins; R-Right, M-Middle,

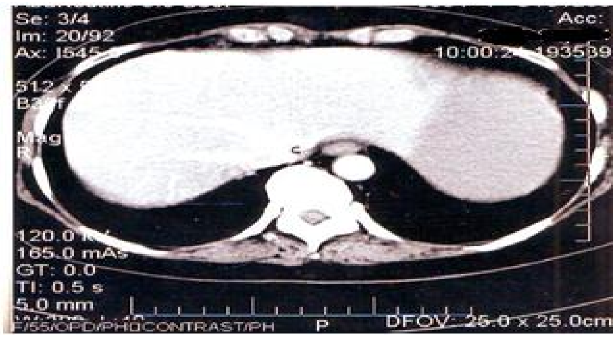

Fig. 4: C-common trunk formed by union of

L-Left hepatic vein, I-Inferior vena cava

middle and left hepatic vein

DISCUSSION

Liver is divided into two functional lobes with right and left division of portal vein. They are further divided by three major hepatic veins into four segments and eight subsegments.[1] These intersegmental fissures contain hepatic veins. Usually no major tributary cross this plane and thus provide a relatively avascular plane during surgery. But occasionally, such plane could be traversed by a relatively large vein and demands extra precaution. Each sector is fed by portal pedicle accompanied by hepatic artery and bile duct. These vessels define segments of liver which are useful during liver surgery for trauma, malignancy, resection and transplantation. CT scan is less operator dependent and more reproducible. It combines better resolution with excellent spatial orientation.[2]

Liver has homogenous architecture supported by reticular meshwork. Blunt dissection is required to expose the blood vessels.[4] Portal vein divides directly into left portal vein and anterior and posterior segmental veins; tributaries of right portal vein only in 12 to16 % of cases.[7] The significance of internal diameters of the major vessels is underlined by Gupta et al 1979 but they have not given the values. These normative derivations can help to label small or large caliber vessels during diagnostic procedures and surgery.

All the three hepatic cranial veins; right, middle and left drain independently into inferior vena cava. But it is not unusual for them to join as they approach IVC forming various patterns.[8] The different patterns observed in the present study are compared with the findings of Gupta et al (1979). The following two patterns were not encountered during present as well as reference study.

1. Left common trunk formed by union of LHV and right and left radical of MHV; separate opening for RHV.

2. Right common trunk formed by union of RHV and right radical of MHV; separate opening for LHV and left radical of MHV.

As the hepatic veins approach IVC they or their tributaries may join to form a common trunk and then drain into it. Such common trunk was observed in 19 of the 50 cases studied. The internal diameter is measured when present. The diameter and length of such pedicle will dictate the type of anastomosis feasible between the donor and recipient's vessel.[9] Following classification is designed and used by Wind et al in their study.

Morphologic criteria:[8]

I- No branch within 1cm of the common trunk from its entry into the IVC. No branches empting directly into IVC.

II- One or more branches within 1cm of the common trunk from its entry into the IVC. No branches empting directly into IVC.

III- One or more branches opening directly into IVC irrespective of the common trunk.

IV- No common trunk.

Ramification of hepatic vessels within 1cm from IVC makes it less useful as a pedicle for both resection and transplantation.[10] Gupta et al (1979) have discussed the significance of this branching pattern in their study. But they have not classified the data into number of ramifications; 3, 2, 1 and zero.RHV is always present. LHV and MHV may be absent due to its tributaries joining with other vein to form common trunk or when these tributaries drain directly into IVC.

The angulations between major radicles of hepatic veins are expressed in terms of mean and standard deviation. This may help to plan surgery as indentations on liver surface do not correspond to the fissures during resection, either segmentectomy or lobectomy; the glissons capsule is cut with a knife. Then the liver tissue is teased away either with blunt end of knife or a small sucker. The prior knowledge of placement of hepatic veins with respect to each other will help in deciding the plane of dissection.[11]The blood supply of caudate lobe is not included in this study. Since they have small caliber of 0.8mm to pinhole; the resolution during routine abdominal CT used in the present study does not show these vessels.

CONCLUSION

The architecture varies from person to person so we only get to know range of variations that can be expected from such a study. Study of internal architecture with CT scan followed by dissection on same cadaveric liver specimen will stipulate the accuracy and advantage of CT as preoperative mapping tool for liver surgeries.

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