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ORIGINAL ARTICLE

COLOR DOPPLER EVALUATION OF HEPATIC VESSELS AND PORTAL VENOUS SYSTEM IN LIVER DISEASES WITH PATHOLOGICAL CPRRELATION

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ABSTRACT: Color Doppler sonography is an important noninvasive procedure for detecting abnormalities in hepatic vasculature in various liver diseases. Ultrasound findings associated with portal hypertension include enlarged diameter of the portal vein, lack of respiratory variation in the portal vein or its tributaries, hepatofungal portal flow direction, decreased portal velocity or volume, and the presence of collaterals or varices. Not only portal hypertension but various other liver diseases are associated with abnormalities noted in hepatic vasculature. An abnormal liver texture and ascites are also commonly seen and are usually related to accompanying cirrhosis. **PORTAL VEIN:** The portal vein is seen in about 97% of normal patients; failure to visualize it can suggest the presence of pathology, such as thrombosis. No intraluminal echoes with frequent echogenic border. **HEPATIC ARTERY:** Proximal hepatic artery is best seen at celiac trunk while distal hepatic artery is seen at the level of main portal vein. On Doppler assessment low resistant waveform pattern is seen with systolic and diastolic component. **IVC (INFERIOR VENA CAVA):** Normal IVC has Low level intra luminal echoes within the lumen and changes occur during respiration. On Doppler assessment continuous triphasic waveform with respiratory variation. **HEPATIC VEIN:** Color Doppler is a key tool, since the hepatic veins may be difficult to visualize with B-mode imaging alone when the liver is enlarged or cirrhotic. **AIM:** To evaluate the abnormalities of hepatic vessels and portal vein in various liver diseases and role of colour Doppler in portal and hepatic vessels various liver disease with histopathological correlation. **MATERIAL AND METHOD:** A prospective study and is conducted in Department of Radiodiagnosis, N.S.C.B. Medical College, Jabalpur M.P.), over a period of one year (2011-2012). To evaluate the colour Doppler of hepatic vessels and portal venous system in liver disease with pathological correlation. **INCLUSION CRITERIA:** All patients (M/F of all age group) having liver diseases (Medical or Surgical) as diagnosed on various investigations, using curvilinear and linear probe of machine (Wipro GE (Logic 3 Expert-Ay15CUK) and Siemens (Sonoline G-50)). First 2D sonography was conducted and then color Doppler assessment of various vessels including Portal vein, hepatic artery and hepatic vein, inferior vena cava was done. **RESULTS:** Liver pathology was evaluated by 5 and 10 MHz electronically focused curvilinear and linear transducer with patient in supine position with direct contact method. The age ranges from 8 to 73 years. Most common age group affected was between 50 to 60 years. In this study 26(57.7%) cases were male and rest of 19(42.2%) cases was female. out of these 45 cases, 29(64.4%) cases were from rural area and rest of 16(35.5%) cases belonged to urban area. In our study 11(24.4%) cases had positive history of various types of addiction. Most common presenting complaint was abdominal pain which is found in 35(76%) cases. In present study out of 45 cases, on USG 15(33.33%) cases were detected as having liver mets, 15(33.33) had cirrhosis with portal hypertension, 5(11.1%) patient had hepatocellular carcinoma and 3(6.6) patients had liver hydatid cyst and 3(6.6%) other had abscess while 1(2.2%) had liver hemangioma and 1(2.2%) had fatty infiltration in liver. Final diagnosis was confirmed by

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histopathology in all these patients. **CONCLUSION:** Color Doppler study in liver hemangioma has not any added advantages over 2D sonography. Color Doppler study in infra hepatic liver cyst has not yield any extra information and vascular changes were seen in large size liver due to compression of adjacent vessels.

KEYWORDS: Color Doppler Sonography, Hepatic Artery, Hepatic vein, Portal vein, Liver Cyst, IVC.

INTRODUCTION: Color Doppler sonography is an important noninvasive procedure for detecting abnormalities in hepatic vasculature in various liver diseases. Ultrasound findings associated with portal hypertension include enlarged diameter of the portal vein, lack of respiratory variation in the portal vein or its tributaries, hepatofungal portal flow direction, decreased portal velocity or volume, and the presence of collaterals or varices.[1-2] Not only portal hypertension but various other liver diseases are associated with abnormalities noted in hepatic vasculature. An abnormal liver texture and ascites are also commonly seen and are usually related to accompanying cirrhosis.[3]

It has already been documented that increased vascularity and abnormal waveform pattern seen in hepatic artery in malignant liver tumour while benign tumours have no or minimal effect. Similarly some medical liver disease like cirrhosis and budd-chiari syndrome is associated with hepatic vascular abnormalities.

IN NORMAL INDIVIDUAL GRAYSCALE AND DOPPLER CHARACTERISTIC OF VARIOUS VESSELS ARE AS FOLLOWS:

PORTAL VEIN: The portal vein is seen in about 97% of normal patients; failure to visualize it can suggest the presence of pathology, such as thrombosis. No intraluminal echoes with frequent echogenic border. On Doppler assessment it shows low velocity signal with respiratory variation and smooth colour fill in vessel. A sudden onset of ascites should prompt careful examination of the portal vein for thrombosis. With deep inspiration, the normal diameter may increase to about 16 mm resulting in an overestimation of portal vein diameter. As pressure increases, portal blood flow may become pulsatile. Color Doppler sonography is superior to gray-scale and spectral Doppler imaging in diagnosing partially occluded vessels. Clot detection by gray-scale imaging is difficult when the thrombus is hypoechoic.[4]

HEPATIC ARTERY: Proximal hepatic artery is best seen at celiac trunk while distal hepatic artery is seen at the level of main portal vein. On Doppler assessment low resistant waveform pattern is seen with systolic and diastolic component. Increased hepatic -arterial flow is seen in severe portal hypertension. Arterial enlargement also may be seen occasionally in vascular liver tumors such as focal nodular hyperplasia and hepatocellular carcinoma.[5]

IVC: Normal IVC has Low level intra luminal echoes within the lumen and changes occur during respiration. On Doppler assessment continuous triphasic waveform with respiratory variation.

HEPATIC VEIN: Color Doppler is a key tool, since the hepatic veins may be difficult to visualize with B-mode imaging alone when the liver is enlarged or cirrhotic. Right, left and middle hepatic veins are veins with imperceptible wall and show triphasic pattern similar to IVC and flow pattern is phasic in response to both cardiac and respiratory cycles. The hepatic veins have two periods of forward flow during the cardiac cycle, corresponding to the two phases of right atrial filling.[6]

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Here in this study we want to establish role of color Doppler in various liver disease which are associated with hepatic vascular changes.

AIMS AND OBJECTIVES:

1. To evaluate the abnormalities of hepatic vessels and portal vein in various liver diseases.
2. To evaluate the role of colour Doppler in portal and hepatic vessels various liver disease with histopathological correlation.

MATERIAL AND METHODS: This is a prospective study and is conducted in Department of Radiodiagnosis, N.S.C.B. Medical College, Jabalpur M.P.), over a period of one year (2011- 2012). All patients (M/F of all age group) having liver diseases (Medical or Surgical) as diagnosed on various investigations are included in the study.

Sonography and colour Doppler study was done in Department of Radiodiagnosis using curvilinear and linear probe of machine (Wipro GE (Logic 3 Expert - Ay 15 CUK) and Siemens (Sonoline G-50)). First 2D sonography was conducted and then color Doppler assessment of various vessels including Portal vein, hepatic artery and hepatic vein, inferior vena cava was done.

On color Doppler assessment flow pattern, velocity, direction, RI and PI values of vessels along with its diameter were studied. Study of collaterals if present was also done (Portal venous system detail examination was done only if portal vein diam. > 15 mm at hilum) statistical analysis was done according to data collection.

RESULT:

Age Group		**No. of Patients**	**%age**
1	0-10 years	3	6.6
2	11-20 years	6	13.3
3	21-30	4	8.8
4	31-40	6	13.3
5	41-50	11	24.4
6	51-60	12	26.6
7	>61	3	6.6
Gender			
1	Male	26	57.7
2	Femals	19	42.2
Locality			
1	Rural	29	64.4
2	Urban	16	35.6
Addiction			
1	Present	11	24.4
2	Absent	34	75.5
Presenting Complaint		**Frequency**	**%age**
1	Abdominal Pain	34	75.6
2	Breast Lump	1	2.2
3	Vomiting mixed with blood	2	4.4
4	Abdominal distension	3	6.7
5	Swelling	2	4.4
6	Fever	1	2.2

DOI: 10.14260/jemds/2015/2111

7	Bleeding PR	1	2.2
Liver Pathology		**No. of Patients**	**%age**
1	Mets	15	33.33
2	Cirrhosis with portal HTN	15	33.33
3	Primary liver tumour(HCC)	5	11.11
4	Liver abscess	3	6.6
5	Liver cyst	3	6.6
6	Haemangioma of liver	1	2.2
7	Fatty infiltration of liver	1	2.2

Table 1: PATIENTS CHARACTERISTIC

Sl. No.	**Diagnosis**	**Hepatic arterial parameter**			
		RI (increased)	**% age**	**PI (increased)**	**% age**
1	Mets	10	66.6	10	66.6
2	Cirrhosis with portal HTN	12	80	12	80
3	Primary liver tumour(HCC)	4	80	4	80
4	Liver abscess	0	0	0	0
5	Liver cyst	0	0	0	0
6	Haemangioma of liver	0	0	0	0
7	Fatty infiltration of liver	0	0	0	0

Table 2: ARTERIAL PARAMETER IN LIVER PATHOLOGY

Sl. No.	**Diagnosis**	**Portal vein parameter**							
		Dia. ed	**% age**	**Flow pattern Abn.**	**% age**	**Flow velocity Abn.**	**% age**	**Direction of flow Abn.**	**% age**
1	Mets	2	13.3	5	33.3	5	33.3	5	33.3
2	Cirrhosis with portal HTN	10	66.6	10	66.6	10	66.6	10	66.6
3	Primary liver tumour(HCC)	0	0	2	40	2	40	2	40
4	Liver abscess	0		0		0		0	
5	Liver cyst	0		0		0		0	
6	Haemangioma of liver	0		0		0		0	
7	Fatty infiltration of liver	0		0		0		0	

Table 3: PORTALVEIN PARAMETER IN LIVER PATHOLOGY

DOI: 10.14260/jemds/2015/2111

Sl. No.	Diagnosis	Hepatic arterial parameter			
		Diameter ed (compressed)	% age	Abnormal Flow pattern	% age
1	Mets	3	20	3	20
2	Cirrhosis with portal HTN	5	33.3	5	33.3
3	Primary liver tumour(HCC)	1	20	3	60
4	Liver abscess	0	0	0	0
5	Liver cyst	1	33.3	1	33.3
6	Haemangioma of liver	0	0	0	0
7	Fatty infiltration of liver	0	0	0	0

Table 4: VEIN PARAMETER IN LIVER PATHOLOGY

Sl. No.	Diagnosis	Hepatic arterial parameter			
		Diameter ed (compressed)	% age	Abnormal Flow pattern	% age
1	Mets	0	0	2	13.3
2	Cirrhosis with portal HTN	0	0	4	26.6
3	Primary liver tumour(HCC)	1	20	1	20
4	Liver abscess	0	0	0	0
5	Liver cyst	0	0	0	0
6	Haemangioma of liver	0	0	0	0
7	Fatty infiltration of liver	0	0	0	0

Table 5: PARAMETER IN LIVER PATHOLOGY

DISCUSSION: Present study was done in 45cases, out of which majority of cases were in 4th to 5th decade age group. In this study 26(57.7%) cases were male and rest of 19(42.2%) cases was female. out of these 45 cases, 29(64.4%) cases were from rural area and rest of 16(35.5%) cases belonged to urban area. In our study 11(24.4%) cases had positive history of various types of addiction. Most common presenting complaint was abdominal pain which is found in 35(76%) cases.

In present study out of 45 cases, on USG 15(33.33%) cases were detected as having liver mets,15(33.33) had cirrhosis with portal hypertension, 5(11.1%) patient had hepatocellular carcinoma and 3(6.6) patients had liver hydatid cyst and 3(6.6%) other had abscess while 1(2.2%) had liver hemangioma and 1(2.2%) had fatty infiltration in liver. Final diagnosis was confirmed by histopathology in all these patient.

On Doppler assessment of various vessels in different liver pathology following results were found.

HEPATIC ARTERY CHANGES IN LIVER PATHOLOGY: In liver metastasis, hepatic artery flow velocity was high and increased RI and PI values were found in 66.66% cases, while rest of cases revealed no change in hepatic artery flow characteristics. Joynt LK, et al (1995) and Tanaka K, et al (1993) found that in general, low resistance arteries normally have an RI of 0.550.7.[7-8]

DOI: 10.14260/jemds/2015/2111

In metastasis hepatic artery flow velocity was high and increased P1 and RI values [>0.7] were found in 66.66% cases while rest of the patient revealed no change in hepatic artery flow characteristics.

In out of 15 patients of cirrhosis with portal hypertension, in 80% cases were high hepatic artery flow velocity along with increased RI and PI(0.7) values. Out of these 12 patients 5(41.66%) patients had portal vein thrombosis and all pts had altered parameter. Wachsberg et al documented in their study of increased hepatic arterial flow is seen in severe portal hypertension.[1]

Gaiani S, Bolondi L, Li Bassi S, et at: 1989. Found that when portal hypertension results from right heart failure pulsation may present in Doppler signal.[9] hepatic artery blood flow increased in portal hypertension caused secondary to liver cirrhosis.

Rails PW (1990) Found that increased hepatic arterial flow is seen in severe portal hypertension.[10]

Reuter concluded in their study that hepatic arterial RE is not useful for diagnosing cirrhosis or predicting its severity.[11]

In out of 45 patients, we found 5 cases primary liver cell carcinoma(HCC), In out of 5cases, 4(80%) cases with hepatocellular carcinoma showed altered parameter of hepatic arteries and flow velocity was typically very high in these patients and both systolic and diastolic velocity were high and RI was below 0.5.

Gaini et al found in their study that arterial enlargement also may be seen occasionally in vascular liver tumors such as focal nodular hyperplasia and hepatocellular carcinoma.[12]

Taylor et al also16 found in their study that Doppler 5MHz were specific for hepatocellular carcinoma lesion.

Tanaka K. Numata K H, 1993 et al[13] used colour and described a fashel parttern in 75% and internal vascularity in 65%. In out of 45 patients, we found 3(6.6%) cases of liver abscess, in these cases there was no change found in hepatic artery flow characteristics.

In out of 45 cases, we found 1(2.2%) case of haemangioma of liver in this case there was no change found in hepatic artery flow characteristics.

In out of 45 cases, we found 1(2.2%) case of fatty infiltration of liver in these cases there was no change in hepatic artery flow characteristics. Portal flow characteristics in various liver disorders were as follows- In out of 15cases of liver mets, in 5(33.3%) cases we found abnormal flow pattern, velocity and direction of portal vein.

Zweibel WJ (1995), found that angle corrected spectral Doppler tracing of the main portal vein in normal fasting patients demonstrate mean flow typically ranging from 15 to 18 cm. per/sec.[2,3]

In out of 45 cases, we found 15(33.3%) cases of cirrhosis with portal hypertension, in out of these 15 cases, In 10(66.6%) cases we found increased portal vein diameter and abnormal flow pattern, velocity and direction of flow. In rest of 5 cases [30%] portal vein diameter was decreased because of thrombosis.

Grant EG et al found in their study that Continuous hepatofugal flow in the portal vein trunk is found with an overall prevalence of 8.3% in patients with liver cirrhosis.[6] Von Herbay A, et al(2000) found that continuous hepatofugal flow in braches of the portal vein is a specific sign for portal hypertension.[14]

Reuter SR, et al (1975) found that in portal hypertension as portal venous flow to the liver decrease arterial flow increases.[11]

DOI: 10.14260/jemds/2015/2111

In out of 5 cases of primary HCC, in 2(40%) cases we found abnormal flow pattern, velocity and direction of flow in portal vein because these cases had portal vein thrombosis due to tumour thrombus.

In present study of 45 cases, we found 3(6.6%) cases of liver abscess here there was no change in portal vein.

HEPATIC VEIN CHANGES IN LIVER PATHOLOGY: In out of 15cases of liver mets, in 3(20%) cases we found loss of respirophasic pattern and also found changes in diameter (compressed) in hepatic vein. In out of 15 cases of cirrhosis with portal hypertension, in 10(66.6%) cases, we found decreased in diameter and loss of respirophasic pattern in hepatic vein.

While rest of our cases showed Colli A, et al (1994) and Bolondi L, et al (1991) found that Liver parenchymal disease impairs the compliance of a hepatic decreasing and flattening phasic oscillations. Flattening of phasic oscillations within the hepatic venous system is seen in 50 to75% of patients with cirrhosis.[15-16]

Wachsberg RM, et al (1995) the high right atrial I pressure is presumably responsible for a pressure- related hepatic venous out-flow block with subsequent trans-sinusoidal hepatoportal shunting, similar to the mechanical outflow block that causes reversed pulsatile flow in liver cirrhosis.[17]

In out of 5 cases of HCC, in 3(60%) cases we found loss of respirophasic pattern in hepatic vein and in 1(20%) case we found decreased (compressed) diameter of hepatic vein.

Becker CD, Cooperberg described that hepatic vein obstruction is the presence of echogenic intra luminal material (thrombus or tumor) accompanied by absence of hepatic vein flow. If the hepatic vein is narrowed but not completely blocked, focal elevated velocity and post steno tic turbulence may be seen.[18]

In 3 cases of liver abscesses, we found no change in hepatic vein. While Syke AM, Jang HJ done a study on liver abscess patient and found portal vein thrombosis in 42% and hepatic vein thrombosis in 22% of their cases.[19] In 3 cases of liver cyst, in 1(33.3%) case, we found change in hepatic vein diameter and loss of respirophasic pattern because this was very closely situated to middle hepatic vein and was compressing it. We found no change in hepatic vein in case of haemangioma of liver and in fatty infiltration of liver.

IVC CHANGES IN LIVER PATHOLOGY: In out of 15 cases of liver mets, in 2(13.3%) cases, we found loss of variation in diameter on inspiration in IVC.

In out of 15 cases of cirrhosis with portal hypertension, in 4(26.6%) cases, we found loss of variation in diameter on inspiration in IVC.

Hiroshi Kitamura, et al (2005) found that in the normal liver group, the maximal diameter of the vena cava was 2.35±0.34 cm (mean±SD), and this was reduced by 1.30±0.67cm (Range, 0.42.85 cm) during deep inspiration. In the cirrhotic patient group, the maximal diameter was 1.74±0.35 cm, and this was reduced by 0.03±0.09 cm (Range, 0.0-0.4 cm), (P<.0001)(60) In out of 5 cases of HCC, in 1(20%) case, we found loss of variation in diameter on inspiration in IVC.

In 3 cases of liver abscesses, hemangioma, liver cyst and fatty infiltration we found no change in IVC.

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Thomas B et all report two cases of hepatic actinomycotic abscesses with contrasting features, one featuring an inferior vena cava(IVC) thrombus (Presumed infected) and septic pulmonary emboli.[20]

Rajagopal KV, et al found and published a case of 15-x 14-cm cystic mass involving the medial segment of the left hepatic lobe and the anterior segment of the right hepatic lobe and was compressing IVC.[21]

SUMMARY AND CONCLUSION: Total 45 cases of various liver pathology attending the various; surgical, medicine and paediatric OPD were referred to us with a brief history, physical examination and a provisional clinical diagnosis. Liver pathology was evaluated by 5 and 10MHz electronically focused curvilinear and linear transducer with patient in supine position with direct contact method.
In our study group age ranges from 8 to 73years. Most common age group affected was between 50 to 60 years.

In this study 26(57.7%) cases were male and rest of 19(42.2%) cases was female. out of these 45 cases, 29(64.4%) cases were from rural area and rest of 16(35.5%) cases belonged to urban area. In our study 11(24.4%) cases had positive history of various types of addiction. Most common presenting complaint was abdominal pain which is found in 35(76%) cases.

In present study out of 45 cases, on USG 15(33.33%) cases were detected as having liver mets, 15(33.33) had cirrhosis with portal hypertension, 5(11.1%) patient had hepatocellular carcinoma and 3(6.6) patients had liver hydatid cyst and 3(6.6%) other had abscess while 1(2.2%) had liver hemangioma and 1(2.2%) had fatty infiltration in liver. Final diagnosis was confirmed by histopathology in all these patients.

On Doppler assessment of various vessels *in* different liver pathology following results were found:

1. In liver metastasis 66% cases revealed change in hepatic artery flow pattern which was in form of increased velocity as well as increased RI and PI [.0.71 value of vessels. In this group of patients portal flow changes were seen in 33% patient, where portal vein dilatation, decreased velocity was detected. In liver metastasis hepatic vein involvement seen in 20 % cases in form of vein compression and dampening of waveform pattern. Present study revealed 13% cases involving IVC and decreased waveform and loss of respirophasic variation seen.
2. In cirrhosis with portal hypertension group of patients, hepatic artery changes were seen in 80 % of cases. In these cases hepatic artery diameter was increased and increase in velocity with high RI and PI values were found. Portal vein changes were varied according to etiology of cirrhosis and in 66% cases portal vein diameter was increased, while in 33% Cases decreased portaivein diameter was seen because of portal vein thrombosis.
   Portal vein hepatofugal flow seen in 66% cases and decrease velocity with loss of undulating pattern was present in all patients.
   In this group of patient 66% cases revealed change in hepatic vein also where loss of respirophasic variation seen.
   VC showed minimal involvement and compression seen in 20% cases.
3. Hepatocellular carcinoma cases showed maximum changes in hepatic artery flow with typically high velocity diastolic and systolic flow and decreased RI, PI [0.5] value. Portal vein involvement seen in 40 % cases and changes were due to tumor thrombus. 60% cases revealed change in hepatic vein with loss of respirophasic variation and its compression while 20% cases showed

IVC involvement. In liver abscess, liver fatty infiltration and hemangioma cases no changes were detected in any of the vessels.

In liver disease not only hepatic artery and portal vein assessment should be done but assessment of hepatic vein and intra hepatic IVC helps in diagnosis. Maximum vascular involvement occurs in cases of cirrhosis with portal hypertension, hepatocellular carcinoma and metastatic group of liver disease of proper and detail Doppler study of hepatic artery, hepatic vein, portal vein and IVC should be done in these cases which are helpful to differentiate one disease entity from other.

In hepatocellular carcinoma hepatic artery showed typically higher velocity with decreased RI, PI values while in cirrhosis and metastatic group high hepatic artery flow with increased RI, PI values were noticed. In portal hypertension portal vein changes seen in maximum patients and when combined with hepatic artery changes helped in diagnosis. In liver mets Doppler study revealed vascular changes but vascular changes were' independent of origin of mets.

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