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Original Research Doppler Sonography for Surrogate Markers of Gastro-Oesophageal Varices in Chronic Liver Disease

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Abstract

Introduction: Gastro-oesophageal varices lead to a major cause of morbidity and mortality in CLD with Portal Hypertension requiring repeated endoscopies for diagnosis and follow up. Sonographic surrogate markers for varices are being searched for and evaluated to aid in diagnosis and follow up.

Aim of the work: To determine the accuracy of primary Doppler indices of hepatic artery, splenic artery, middle hepatic vein, superior mesenteric artery and calculated complex Doppler parameters in diagnosis of oesophageal varices.

Patients and Methods: 96 cases of CLD underwent Doppler sonography of portal venous system, hepatic arteries and hepatic veins. Conventional Doppler parameters, liver congestion index, liver vascular index and portal hypertension index were noted. Patients underwent endoscopy for detecting and grading varices. The Doppler findings were correlated with endoscopy findings.

Results: *PSV, RI and PI values alone of splenic artery, hepatic artery and SMA do not correspond to presence or absence of varices. Liver congestive index, liver vascular index and portal hypertension index and wave forms in middle hepatic vein show correlation with presence or absence of varices.*

Conclusions: Liver congestion index >0.145 cm x s, liver vascular index < 12 cm/s, portal hypertension index >0.021s/cm and monophasic/biphasic wave form in middle hepatic vein can be used as sonographic surrogate markers for presence of gastro-oesophageal varices in portal hypertension.

Keywords: Chronic Liver Disease, gastro-oesophageal varices, Doppler Sonography, Liver congestion index, liver vascular index and portal hypertension index, Middle hepatic vein wave form.

Introduction

Oesophageal varices form a common cause of morbidity and mortality in patients with cirrhosis.

Oesophageal variceal bleeding can be a lethal with estimated mortality rate as high as 20%.

Endoscopic screening for oesophageal varices is recommended in patients with newly diagnosed chronic liver disease patients, because medical treatment must be considered to prevent bleeding. Identifying patients with high probability for development of oesophageal varices with nonendoscopic and non-invasive methods like ultrasonography can lead to prophylactic therapies and to avoid endoscopy in some patients who have high risk of complications during endoscopy. This study attempts to assess the value of Doppler sonography for the prediction of presence of oesophageal varices in chronic liver disease patients. Endoscopy is used for the confirmation of presence of varices.

Objective

To determine the accuracy of primary Doppler indices of hepatic artery, splenic artery, middle hepatic vein, superior mesenteric artery and calculated complex Doppler parameters in diagnosis of oesophageal varices.

Background

Early diagnosis of liver cirrhosis is essential to prevent the complications including hepatic encephalopathy, variceal bleeding and portal vein thrombosis. The liver parenchymal changes which are seen in patients with cirrhosis include altered echogenicity, nodularity of the surfaces, coarsened echotexture, increased caudate to right lobe size ratio^{1,2}. The presence of varices and splenomegaly represent sequelae of portal hypertension in the case of cirrhosis.

Patients with cirrhosis should undergo endoscopic screening for varices at the time of diagnosis and periodically thereafter if no or small varices are detected. If screening endoscopy showsoesophageal varices, a classification based on size should be assigned. The Paquet's classification³ is as follows:

Grade I: Microcapillaries located in distal oesophagus or oesophago-gastric junction.

Grade II: One or two small varices located in the distal oesophagus.

Grade III: Medium-sized varices of any number. Grade IV: Large-sized varices in any part of oesophagus.

The American Association for the Study of Liver Diseases recommend that all cirrhotic patients should undergo endoscopy at the time of diagnosis of cirrhosis^{4,5}. If no varices are present at index endoscopy, this procedure should be repeated at 2 or 3 years in compensated cirrhosis and yearly in decompensated cirrhosis. Upper endoscopy in cirrhotic patients involves high cost and low compliance, and most often poorly accepted and tolerated, carries with it the risk of infections and requires sedation. The use of non-invasive predictive model would help in selection of patients who are at risk for rupture, candidates for primary prophylaxis and assess response to treatment.

The portal and splanchnic hemodynamics have been studied in an attempt to find non-invasive parameters that could predict the development of portal hypertension and oesophageal varices. There have been many studies to identify the best predictive test criterion, starting from simple Doppler indices to very complex multi-parameter calculated ones. However, results have not been totally satisfactory.

The three major vessels that are assessed on Doppler ultrasound are portal vein, hepatic vein and hepatic artery. In portal vein, wave form, direction of flow, diameter and peak systolic velocity are commonly studied.

Hepatic veins are normally described to have a, s, v, and d waves in a cycle. Since the v wave is not prominent, it can be called triphasic. Alterations in wave forms can be caused by cirrhosis of liver. The abnormal wave forms can be biphasic or monophasic.

'The hepatic arterial waveform is normally pulsatile with low resistance. Liver disease may manifest in the hepatic artery as abnormally elevated (RI >0.7) or decreased (RI <0.55) resistance. High resistance is a nonspecific finding that may be seen in the postprandial state, advanced age, and diffuse peripheral microvascular

(arteriolar) compression or disease, as seen in chronic hepatocellular disease (including cirrhosis) and hepatic venous congestion.'⁶Normal values in hepatic artery are as follows: PSV: $70\pm 10 \text{ cm/s}$; RI: 0.65 ± 0.1 ; PI: 0.92 ± 0.1

Various Doppler parameters have been described for the evaluation of oesophageal varices: Hepatic Artery Resistance Index (HARI), Hepatic Artery Pulsatility Index (HAPI), Splenic Artery Resistance Index (SARI), Splenic Artery Pulsatility Index (SAPI), Liver Congestion Index, Liver Vascular Index (LVI), Portal Hypertensive Index (PHT Index).

Normal PI and RI values of splenic artery, hepatic artery and superior mesenteric artery are as follows: PI of splenic artery: 1.03 ± 0.127 . RI of splenic artery: 0.636 ± 0.055 . PI of Hepatic artery: 0.96 ± 0.147 . RI of Hepatic artery: 0.673 ± 0.065 . PI of Superior mesenteric artery: 3.42 ± 0.92 . RI of Superior mesenteric artery: 0.83 ± 0.05 .

Liver Vascular Index: It is defined as the ratio of portal venous velocity to hepatic artery PI.

LVI = <u>Portal venous velocity</u> Hepatic arterial PI

Iwao et al demonstrated that Liver vascular index is significantly lower in patients (8.7+/-2.1 cm/s) compared to normalpersons (17.2+/-4.3 cm/s) and in patient with oesophageal varices velocities less than 12cm/s are described (sensitivity 97% and specificity 93%). They found that the liver vascular index was highly sensitive and specific Doppler parameter for diagnosing cirrhosis and portal hypertension with a cut off value of 12 cm/s.⁷

Portal Hypertension Index: (Hepatic Artery RI \times 0.69) x (Splenic Artery RI \times 0.87)

Portal Vein Velocity

This is a relatively new calculated parameter described by Piscagliaet al.⁸

Liver Congestion Index or Congestion Index of Portal Vein: It is defined as the ratio of portal vein cross sectional area to portal vein velocity.

LCI = $(\pi \times \text{portal vein diameter}^2/4)$ Portal vein velocity

Normal value: 0.07 \pm 0.03 cm x s

The Congestion Index of the Portal Vein was first described by Moriyasu. Moriyasu established a cut off value that is diagnostic for various categories of liver diseases, from acute hepatitis to liver cirrhosis. Congestion Index values above 0.171 cm x s correlated with cirrhosis and those above 0.180 with idiopathic portal hypertension respectively⁹.

Berzigotti found that Liver Congestion Index was 0.14 ± 0.04 cm x s in patients with Clinically Significant Portal Hypertension¹⁰

Plestina et al demonstrated that at a cut-off value of 0.154cm x sec, the Congestion Index has a sensitivity of 70% and specificity of 64.9% for presence of larger oesophageal varices with the risk of bleeding from oesophageal varices. Congestion Index was significantly higher in the group of patients with oesophageal varices than those without varices.¹¹

Methodology

Research design was hospital-based observational study with Diagnostic Test Evaluation. Study was conducted at Department of Radiodiagnosis, Medical College, Trivandrum during12 months from March 2017.

Inclusion Criteria: Patients over the age of 18 years, with chronic liver disease with (1) coarse echotexture, irregular surface and blunted edge or (2) highly non-homogeneous or coarse echotexture, nodular surface and rounded edge.

Exclusion Criteria: unwillingness to be part of the study, obesity, treatment with vasoactive agents or diuretics, diagnosis of hepatocellular carcinoma and history of recent surgery, splenectomy, cardiac failure and endoscopic or surgical treatment for varices.

Sample size: 96

Sampling technique: All eligible patients are included with no random sampling.

Data Collection & Technique: A questionnaire was used to collect the medical history. After taking Informed consent, patients underwent grey scale sonography using a curvilinear probe of 3.5 - 5.0 MHZ coupled with colour Doppler while fasting for atleast 6 hours. Measurements were made during suspended respiration. The Doppler gate was placed in the portahepatis to measure the Doppler indices of portal vein and hepatic artery, in the hilum of the spleen for splenic artery and vein parameters and in the first part of the SMA near its origin from the aorta for SMA indices. The portal vein diameter was measured with the patient supine, at a point where it crosses the IVC. Velocity measurements conducted at an angle between 30° and 60° . The middle hepatic vein was examined in the longitudinal plane via a right intercostal approach or in the transverse plane with the patient supine via a subcostal approach. All measurements were recorded 1 to 2 cm proximal to the vein's entrance into the inferior vena cava. Plasticity and resistive indices calculated as the mean of 3 consistent measurements. The portal vein, splenic vein and hepatic veins were assessed for calibre, presence or absence of blood flow, direction of flow, velocity and phasicity. Liver Vascular Index, Liver Congestion Index, Portal Hypertension Index were calculated.

The patients then underwent endoscopy to look for presence of varices. Varices were graded by Paquet's classification:

Data Analysis: Data were entered into Excel sheets and categorical variables were expressed as proportions; quantitative variables were expressed as mean and standard deviation. Statistical test of significance - Chi square test for categorical variables and Student's't' test for quantitative variables- was used. Doppler spectral indices and other calculated parameters of portal vein, splenic artery and hepatic artery were compared to endoscopy which was used as gold standard, for diagnostic test evaluation as surrogate markers of presence of oesophageal varices. ROC curves were plotted for LCI, LVI and PHI to find out the optimal cut off values. All statistical analyses were performed with appropriate statistical package (SPSS) and Med Calc softwares.

Observation and Results

Doppler sonography was done in all chronic liver disease patients who were referred to our department, who fulfilled the inclusion criteria, after getting informed consent. A total of 96 patients, were included in the study.

Table 1:	Age	Distribution	of Study	Population
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Age	Frequency	Percentage
≤40	10	10.4
41-50	31	32.3
51-60	35	36.5
61-70	14	14.6
>70	6	6.2
Total	96	100

The distribution of cause of CLD was as follows in the study population. Alcohol: 75 (78.1%), Hepatitis B: 9 (9.4%), Hepatitis C: 6 (6.2%), Hepatitis B&C: 2 (2.1%), Others: 4 (4.2%). Total: 96 (100%).

The distribution of cause of CLD was as follows in the study population with varices. Alcohol: 60 (74.1%), Hepatitis B: 9 (11.1%), Hepatitis C: 6 (7.4%), Hepatitis B&C: 2 (2.5%), Others: 4 (4.9%). Total: 81 (100%).

The distribution of different grades of Child Pugh Score was as follows in the study population. A: 39 (40.6%), B: 48 (50%), C: 9 (9.4%). Total: 96 (100%)

The distribution of different grades of Child Pugh Score was as follows in the study population with varices. A: 27 (33.3%), B: 45 (55.6%), C: 9 (11.1%). Total: 81 (100%)

The distribution of different grades of gastrooesophageal varices was as follows in the study population. No varices: 15, Grade 1: 23, Grade 2: 23, Grade 3: 27, Grade4: 8. Total: 96.

Р 0.000 0.000 0.000 0.003 0.039 0.000 0.001 0.043 0.016 0.041 0.400

0.000

0.000

0.000

Table	2:	Mean	Values	of	doppler	Parameters	in
Patients	s w	vith and	l withou	it V	'arices		

		Varices					
	Pres	sent	Abs	ent			
	(N=	81)	(N=	15)	Р		
	Mean	Sd	Mean	sd			
PVD	14.7	1.8	12.9	1.7	0.001		
PV CSA	1.73	0.42	1.33	0.37	0.001		
SA PSV	52.7	4.2	53.6	4.1	0.425		
SA RI	0.63	0.03	0.64	0.04	0.393		
SA PI	1.31	0.10	1.23	0.12	0.008		
HA PSV	48.8	2.4	50.6	2.0	0.009		
HA RI	0.75	0.04	0.74	0.04	0.412		
HA PI	1.38	0.16	1.42	0.19	0.408		
SMA PSV	46.8	2.9	45.5	3.4	0.114		
SMA RI	0.81	0.02	0.81	0.02	0.845		
SMA PI	2.80	0.15	2.85	0.20	0.212		
LVI	9.91	2.13	12.15	2.94	0.001		
LCI	0.140	0.060	0.087	0.052	0.002		
PHI	0.022	0.006	0.018	0.005	0.006		

Portal vein diameter of the patients with varices were higher (14.7 mm) compared to patients without varices (12.9 mm). Mean LCI of the patients with varices were higher (0.0140) compared to patients without varices (0.060) and mean PHI of the patients with varices were higher (0.022) compared to patients without varices (0.006)

The RI, PI and PSV values of the SA, HA and SMA were almost similar in patients with and without varices except for SA PI which is slightly elevated in patients with varices.

Mean LCI of the patients with varices were higher (0.0140) compared to patients without varices (0.060) and mean PHI of the patients with varices were higher (0.022) compared to patients without varices (0.006)

e 3: Mean Va	3: Mean Values of doppler Parameters in Different Grades of Varices										
				Va	rices						
	Grade	1 (N=23)	Grade 2	2 (N=23)	Grade 3	(N=27)	Grade 4	4 (N=8)			
	Mean	sd	Mean	Sd	Mean	sd	Mean	sd			
PVD	12.83	1.43	14.92	1.35	15.59	1.45	16.56	0.53			
PV CSA	1.31	0.32	1.76	0.31	1.92	0.33	2.15	0.14			
SA PSV	55.25	4.04	53.00	4.33	50.89	3.39	50.22	2.11			
SA RI	0.623	0.034	0.628	0.020	0.642	0.019	0.651	0.011			
SA PI	1.292	0.114	1.358	0.078	1.304	0.098	1.267	0.087			
HA PSV	50.67	1.61	48.88	2.63	47.74	2.18	47.11	1.27			
HA RI	0.743	0.037	0.732	0.038	0.761	0.036	0.787	0.017			
HA PI	1.446	0.198	1.342	0.141	1.389	0.125	1.300	0.112			
SMA PSV	47.08	3.12	47.92	2.00	46.22	2.79	44.67	3.16			
SMA RI	0.812	0.026	0.800	0.013	0.810	0.012	0.816	0.009			
SMA PI	2 78	0.14	2 78	0.15	2.83	0.16	2.83	0.13			

2.03

0.044

0.005

8.83

0.168

0.025

1.67

0.050

0.005

Tab

The mean value of LCI and PHI increases when the grade of the varices increases whereas an inverse relation is noted with LVI.

11.86

0.082

0.017

1.47

0.042

0.004

9.86

0.142

0.022

LVI

LCI

PHI

The cause of the CLD was statistically analysed for relationship with the presence or absence of varices. The observed difference was not statistically significant (p>0.05).

0.96

0.026

0.003

8.09

0.208

0.030

Table 4: Evaluation of Portal Vein Diameter as Surrogate Diagnostic Test to Predict Presence of the Varices (Positive test constituted by PV diameter >13 mm)

		Oesopha	Oesophageal Varices			
		Present	Absent	Total		
DVD	>13 mm	53	3	56		
PVD	<13 mm	28	12	40		
	Total	81	15	96		

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The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR-, accuracy, false positive rate and false negative rate were 65%, 80%, 94.6%, 30%, 3.27, 0.43, 67.7%, 20% and 35% respectively.

When portal vein diameter more than 13 mm was taken as cut off, the sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR- were 65%, 80%, 67.7%, 94.6%, 30%, 3.27 and 0.43 respectively.

Fable 5:	Statistical	Analysis c	of Relationship	between M.H.V.	Waveform and presence o	of Varices
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		Var	Total			
	Pr	esent	A	bsent	1	otal
MHV SPEC	Ν	%	Ν	%	N	%
Monophasic	21	25.9	2	13.3	23	24.0
Biphasic	38	46.9	2	13.3	40	41.6
Triphasic	22	27.1	11	73.3	33	34.4
Total	81 100.0		15	100.0	96	100.0
$\chi^2 = 11.287 df = 2$		p = 0.00)4			

The middle hepatic vein wave form was compared with presence of varices and it was found to be statistically significant (p<0.05)

Table 6: Evaluation of Presence of Monophasic Waveform in Middle Hepatic Vein as Surrogate Diagnostic

 Test to Predict Presence of the Varices

		Oesopha	Oesophageal Varices				
		Present	Absent	Total			
MHV	Monophasic	21	2	23			
spectrum	Others	60	13	73			
	Total	81	15	96			

The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR-, accuracy, false positive rate and false negative rate

were 26%, 87%, 91.3%, 17.8%, 1.94, 0.85 and 35.4 respectively.

Table 7: Evaluation of Presence of Either of Monophasic & Biphasic Waveforms in Middle Hepatic Vein as
 Surrogate Diagnostic test to Predict Presence of the Varices

		Oesophagea	Oesophageal Varices		
		Present	Absent	Total	
MHV	Monophasic or Biphasic	59	4	63	
Spectrum	Others	22	11	33	
	Total	81	15	96	

The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR-, accuracy, false positive rate and false negative rate

were 73%, 73%, 93.6%, 17.8%, 2.73, 0.37, 72.9%, 27% and 27% respectively.

<u>2</u>019

Table 8: Evaluation of Liver Vascular Index as Surrogate Diagnostic test to Predict Presence of the Varices(Positive test constituted by LVI <12 cm/sec)</td>

		Oesophag		
		Present	Absent	Total
тул	<12	68	9	77
	>12	13	6	19
	Total	81	15	96

The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR-, accuracy, false positive rate and false negative rate

were 84%, 40%, 88.3%, 31.6%, 1.4, 0.4, 77%, 60% and 16% respectively.

Figure 1: ROC Curve for liver Vascular Index



Table 9: Criterion Values and Coordinates of the ROC Curve of Liver Vascular Index

 Criterion values and coordinates of the ROC curve [Hide]

		L .	1			
Criterion	Sensitivity	Specificity	+LR	-LR	+PV	-PV
<6.92	0.00	100.00		1.00		15.2
≤7.33	11.90	100.00		0.88	100.0	16.9
≤7.69	22.62	93.33	3.39	0.83	95.0	17.7
≤7.86	33.33	86.67	2.50	0.77	93.3	18.8
≤9.17	39.29	86.67	2.95	0.70	94.3	20.3
≤9.29	54.76	80.00	2.74	0.57	93.9	24.0
≤10	60.71	80.00	3.04	0.49	94.4	26.7
≤11.25	69.05	53.33	1.48	0.58	89.2	23.5
<mark>≤11.82</mark>	<mark>72.62</mark>	<mark>53.33</mark>	<mark>1.56</mark>	<mark>0.51</mark>	<mark>89.7</mark>	<mark>25.8</mark>
≤11.88	83.33	40.00	1.39	0.42	88.6	30.0
≤12.5	84.52	33.33	1.27	0.46	87.7	27.8
≤12.86	85.71	33.33	1.29	0.43	87.8	29.4
≤13.33	100.00	20.00	1.25	0.00	87.5	100.0
≤19.09	100.00	0.00	1.00		84.8	
		å		å		

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Area under ROC curve of LVI is 0.718. A cut off value of 12 cm/s (Positive test constituted by

LVI<12 cm/s) has sensitivity of 84% and specificity of 40% to predict varices.

Table 10: Evaluation of Portal Hypertension Index as Surrogate Diagnostic test to Predict Presence of the Varices

(Positive test constituted by PHI >0.021s/cm)

		Oesopha		
		Present	Absent	Total
PHI	>0.021	39	2	41
	>0.021	42	13	56
	Total	81	15	96

The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR-, accuracy, false positive rate and false negative rate

were 48.1%, 86.7%, 95.1%, 23.6%, 3.61, 0.61, 54.2%, 13.3% and 51.9% respectively.

Figure 2: ROC Curve for Portal Hypertension Index



Table 11: Criterion Values and Coordinates of the ROC Curve of PHI

Criterion	Sensitivity	Specificity	+LR	-LR	+PV	-PV
≥0.014	100.00	0.00	1.00		84.8	
>0.014	98.81	6.67	1.06	0.18	85.6	50.0
>0.015	88.10	40.00	1.47	0.30	89.2	37.5
>0.016	64.29	80.00	3.21	0.45	94.7	28.6
>0.019	63.10	80.00	3.15	0.46	94.6	27.9
>0.02	47.62	86.67	3.57	0.60	95.2	22.8
>0.024	44.05	86.67	3.30	0.65	94.9	21.7
>0.027	15.48	93.33	2.32	0.91	92.9	16.5
>0.029	14.29	93.33	2.14	0.92	92.3	16.3
>0.032	1.19	100.00		0.99	100.0	15.3
>0.035	0.00	100.00		1.00		15.2

Area under ROC curve of PHI is 0.744. A cut off value of 0.019 s/cm (PHI >0.019 s/cm constituting

positive test) has sensitivity of 63.1% and specificity of 80% to predict varices.

 Table 12: Evaluation of Liver Congestion index as Surrogate Diagnostic test to Predict Presence of the Varices

(Positive test constituted by LCI>0.145 cm x sec)¹⁰

		Oesopha		
		Present	Absent	Total
LCI	>0.145	38	2	40
LCI	< 0.145	43	13	56
	Total	81	15	96

The sensitivity, specificity, positive predictive value, negative predictive value, LR+, LR, accuracy, false positive rate and false negative rate

were 46.9%, 86.7%, 95%, 23.2%, 3.52, 0.61, 53.1%, 13.3% and 53.1% respectively.

Figure3: ROC Curve for liver Congestion Index



Table 13: Criterion Values and Coordinates of the ROC Curve of LCI

Criterion	Sensitivity	Specificity	+LR	-LR	+PV	-PV
≥0.054	100.00	0.00	1.00		84.8	
>0.054	100.00	6.67	1.07	0.00	85.7	100.0
>0.057	98.81	13.33	1.14	0.089	86.5	66.7
>0.059	88.10	40.00	1.47	0.30	89.2	37.5
>0.063	78.57	66.67	2.36	0.32	93.0	35.7
>0.083	64.29	80.00	3.21	0.45	94.7	28.6
>0.126	63.10	80.00	3.15	0.46	94.6	27.9
>0.136	47.62	86.67	3.57	0.60	95.2	22.8
>0.18	42.86	86.67	3.21	0.66	94.7	21.3
>0.183	15.48	93.33	2.32	0.91	92.9	16.5
>0.206	14.29	93.33	2.14	0.92	92.3	16.3
>0.227	1.19	100.00		0.99	100.0	15.3
>0.252	0.00	100.00		1.00		15.2

Area under ROC curve of LCI is 0.761. A cut off value of 0.126 (positive test constituted by LCI

>0.126) has sensitivity of 63.1% and specificity of 80% to predict varices.

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Figure 4: A patient with alcoholic cirrhosis and Grade 2 varices having Liver vascular index in normal range (24.17 cm/s), congestion index in the normal range (0.0692) and portal hypertension index in normal range (0.0105). Doppler of the Main Portal Vein shows borderline intermittent reversal of flow. PVD= 16 mm, PSV= 28.7 cm/s.



Figure 5: The same patient as in Fig. 4. Triphasic waveform in middle hepatic vein



Figure 6: A patient with alcoholic cirrhosis and Grade 2 varices havingliver vascular index in abnormal range (9.186 cm/s), congestion index in the normal range (0.1012) and portal hypertension index in abnormal range (0.0217). Doppler of the superior mesenteric artery shows RI 0.88 and PI 2.9.

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Figure 7: A patient with HBV&HCV and Grade 2 varices having liver vascular index in normal range (20.4 cm/s), congestion index in the normal range (0.0528) and portal hypertension index in normal range (0.0142). Doppler ultrasonography of Hepatic artery shows PSV 45.1 cm/s, RI 0.71 and PI 1.23



Figure 8: A patient with alcoholic cirrhosis and Grade 2 varices having liver vascular index in normal range (13.53 cm/s), congestion index in the normal range (0.069) and portal hypertension index in normal range (0.0176). Doppler sonography shows biphasic pattern in middle hepatic vein withpeak velocity 27.1 cm/s.



Figure 9: A patient with alcoholic cirrhosis and Grade 4 varices having liver vascular index in normal range (13.33cm/s), congestion index in the normal range (0.083) and portal hypertension index in abnormal range (0.016). Doppler sonography shows middle hepatic vein with dampened monophasic waveforms.

Discussion

Doppler ultrasonography of the splanchnic circulationwas evaluated for surrogate markers of the oesophageal varices. The study was done on 96 patients.

Portal vein diameter of the patients with varices was higher (14.7 mm) compared to patients without varices (12.9 mm). When portal vein diameter more than 13 mm was taken as cut off, the sensitivity of the test was 65% .The specificity and accuracy obtained were 80% and 67.7% respectively. Positive predictive value is about 94.6% and negative predictive value is 30%. Positive and negative likelihood ratios were 3.27 and 0.43, respectively

The RI, PI and PSV values of the SA, HA and SMA were almost similar in patients with and without varices and no significance was obtained. These idices per se are not very useful as surrogate markers of gastro-oesophageal varices.

Presence of monophasic wave form in middle hepatic vein had low sensitivity (25.39%), but high specificity (86.6%). Though this parameter cannot be used as a screening tool to presumptively diagnose patients with varices, its high specificity may allow a rather firm impression on presence of varices. Such a firm impression can be important in patients who are not fit for endoscopy.

Presence of either of monophasic or biphasic wave form in middle hepatic vein had a higher sensitivity of 72.8% and specificity of 73.3%. This test criterion was found to be superior to RI and PI of the hepatic artery and splenic artery.

For the cut off value, 0.0145 of LCI, suggested in the literature, the sensitivity and specificity were 46.9% and 86.7% respectively. Analysis of ROC curve yields a cut off value of 0.126 with 63.1% sensitivity and 80% specificity to predict presence of varices.

Mean PHI of the patients with varices is higher (0.022) compared to patients without varices (0.006) and was statistically significant. When PHI values more than 0.021 was taken as positivity the sensitivity was 48.1% and the specificity was 86.7%. In this study, a cut off value of 0.019 was associated with 63.1% sensitivity and 80% specificity to predict the varices.

When LVI less than 12 cm/s was taken as positivity of test criterion, the sensitivity was 84% and the specificity was40%. Positive predictive value is about 88.3% and negative predictive value is 31.6%. Positive and negative likelihood ratios were 1.40 and 0.4, respectively.

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The mean values of LCI and PHI increased when the grades of the varices were higher. The mean value of LVI decreased when the grades of the varices were higher and thus an inverse relation was noted with LVI.

The four Doppler parameters, namely, presence of either of monophasic or biphasic wave form in middle hepatic vein, liver congestion index, portal hypertension index and liver vascular index exhibit the potential to be surrogate markers of presence of gastro-oesophageal varices in portal hypertension.

Conclusions

- Conventional Doppler ultrasound indices like Peak Systolic Velocity, Resistive Index and Pulsatility Index of arteries of the splanchnic system, when stated in isolation from poor diagnostic criteria for a presumptive diagnosis of presence of varices at gastroesophageal junction in cases of portal hypertension.
- A cut off value of 13 mm, of main portal vein had sensitivity of 65% and specificity of 80%, positive predictive value of 94.6%, negative predictive value of 30%, positive likelihood ratio of 3.27 and negative likelihood ratio of 0.43, respectively. Its clinical usefulness may be questionable in view of prior conflicting reports in literature.
- Mean Liver Congestion Index of the patients with varices was higher (0.0140) compared to patients without varices (0.060) and was statistically significant. Using the cut off value of 0.0145 given in literature, the sensitivity of the test was 46.9% and specificity 86.7%. In this study, a cut off value of 0.126 for a presumptive diagnosis of presence of oesophageal varices gave sensitivity of 63.1 %, specificity of 80%, positive predictive value of 94.6%.
- Mean Portal Hypertension Index of the patients with varices were higher (0.022)

compared to patients without varices (0.006) and this difference was statistically significant. When using the cut off value of 0.021, the sensitivity was 48.1% and specificity 86.7%.

- In this study, positivity of Portal Hypertension Index value greater than0.019 for a presumptive diagnosis of presence of oesophageal varices gave sensitivity of 63.1 %, specificity of 80% and positive predictive value of 94.6%.
- When LVI less than 12 cm/s was taken as the diagnostic criterion, the sensitivity, the specificity and the accuracy were 84%, 40% and 77% respectively.
- Presence of monophasic waveform in the middlehepatic vein had a low sensitivity (25.93%), but high specificity 86.6%, for a presumptive diagnosis of presence of oesophageal varices.
- Presence of either monophasic or biphasic waveform in the middle hepatic vein had a sensitivity of 72.8%,specificity 73.3%, positive predictive value 93.6%, negative predictive value 33.3%, for a presumptive diagnosis of presence of oesophageal varices..
- The four Doppler parameters, namely, presence of either of monophasic or biphasic wave form in middle hepatic vein, liver congestive index, portal hypertension index and liver vascular index exhibit the potential to be surrogate markers of presence of gastro-oesophageal varices in portal hypertension.

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