Original research article

A Study of Color Doppler Ultrasonography in Evaluation of Portal Hypertension

Dr. Srikanth Sagi, Dr. P. Keerthi Bharathi

[1]Assistant Professor, Department of Radiology, Prathima Institute of Medical Sciences, Naganoor, Karimnagar

[2]Assistant Professor, Department of Radiology, Prathima Relief Institute of Medical Sciences, Sahasra Nagar, Arepally, Mulugu Road, Warangal

Corresponding Author: Dr. Srikanth Sagi

Email- drsrikanth.sagi@gmail.com

Abstract

Background: The leading causes of chronic liver disease, which is still on the rise, include chronic alcohol use, obesity, hepatitis C, and hepatitis B. In cases of cirrhosis, portal hypertension and its effects are a significant source of morbidity and mortality.Ultrasound methods like duplex ultrasonography or spectral imaging the preferred modalities include Doppler imaging, color Doppler imaging, and power Doppler imaging. The present study aimed to identify findings in patients with portal hypertension.

Methods: All cases with clinical suspicion of portal hypertension and all the cases with altered biochemical parameters suggestive of cirrhosis with portal hypertension were included in the study. All patients had abdominal ultrasonography using a curvilinear 2–5Mhz probe in conjunction with color Doppler technology. While the USG is being done, the patient will be advised to lie comfortably supine. Doppler Hepatic vein waveforms will be captured in suspended expiration for at least five seconds (end-expiratory). In longitudinal scanning planes, the maximum and minimum velocities of descending hepatic vein flow will be determined, and the damping index will be computed.

Results: out of n=35 cases included in the study, n=30 cases had a portal vein diameter of < 20mm and >20mm in n=2 cases. Similarly, portal lumen size was normal in n=28 cases and flow status in the maximum number of cases was hepatopetal and No flow was detected in n=8 cases. The damping index of the hepatic vein in a majority of patients (85.71%) presented with <0.6 and (14.28%) had >0.6 damping index hepatic vein.

Conclusion: Portal hypertension and its complications account for significant morbidity and mortality. Ultrasonography with added color Doppler helps in evaluating portal hypertension and differentiation of sinusoidal, pre or post-sinusoidal causes of portal hypertension. The Colour Doppler also offers accurate information in locating and defining the portal vein in patients with portal hypertension and aids in determining the presence of various portosystemic collaterals.

Keywords: Child Turcotte-Pugh score, Portal hypertension, Ultrasound, Color doppler study, Damping Index.

Introduction

Chronic alcohol consumption, obesity, hepatitis C, and hepatitis B are the main causes of chronic liver disease, which is still on the rise. [1, 2] Portal hypertension and its consequences are a major cause of morbidity and mortality in cirrhotic patients. Chronic liver illness is most frequently the source of the common syndrome known as portal hypertension, which is defined by an elevated portal pressure gradient (PPG; the difference in pressure between the portal vein and the inferior vena cava [IVC], which represents the perfusion pressure of the liver with portal blood). The PPG typically ranges between 1- and 5 mm Hg. When the PPG rises to 10 mm Hg or more, portal hypertension becomes clinically significant (linked to risk of clinical consequences). Portal hypertension with values between 5- and 9-mm Hg is subclinical. [3-5] Ascites, hypersplenism, and oesophageal variceal hemorrhage are typical manifestations of portal hypertension and associated consequences. Because they are non-invasive, quick, and extremely sensitive and specific, ultrasound techniques such duplex ultrasonography, spectral Doppler imaging, color Doppler imaging, or power Doppler imaging are the modalities of choice in portal hypertension imaging. A key prognostic indicator is the Child's categorization as modified by Pugh et al., [6] which seeks to measure liver damage. To evaluate portal hypertension and distinguish between sinusoidal, pre-, and post-sinusoidal causes, ultrasonography with color Doppler is helpful. Additionally, it makes it possible to accurately search for complications such as oesophageal varices and portal vein thrombosis. The current study was conducted to assess the range of color Doppler sonographic findings, measure the Hepatic Vein Damping Index (DI), and correlate these findings with the severity of liver dysfunction (Child-Pugh score) in patients with portal hypertension in light of these benefits and the paucity of literature on the subject.

Material and Methods

This cross-sectional study was conducted in the Department of Radiology, in collaboration with the Departments of Medicine and Surgery, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana State. Intuitional Ethical committee permission was obtained for the study. Written consent was obtained from all the patients included in the study.

Inclusion Criteria

1. All cases with clinical suspicion of portal hypertension.
2. All cases with altered biochemical parameters s/o cirrhosis with portal
3. Hypertension.
4. Males and females
5. Aged 30 years and above

Exclusion criteria

1. Patients not willing to study
2. Pregnant women.
3. Patients presenting with abdominal trauma.

Demographic characteristics of the study population such as age, and sex of patients with clinical suspicion of chronic liver disease and portal hypertension, will be referred to the Department of Radiodiagnosis collected in a predesigned pre-structured format.

Parameters studied*:* Hepatic vein Damping Index (DI) using Sonography with low-frequency transducer (frequency 2-5MHZ) Equipment: Seimens Accuson 300, Seimens Medical Solutions USA, Inc. Doppler sonography study of liver and Laboratory investigations namely Serum total bilirubin, Serum albumin, PT INR were included. If there are features suggesting

portal hypertension, then color Doppler and spectral tracing studies of the portal vein and hepatic vein will be done.
All patients had abdominal ultrasonography using a curvilinear 2–5Mhz probe in conjunction with color Doppler technology. While the USG is being done, the patient will be advised to lie comfortably supine. Doppler Hepatic vein waveforms will be captured in suspended expiration for at least five seconds (end-expiratory). In longitudinal scanning planes, the maximum and minimum velocities of descending hepatic vein flow will be determined, and the damping index will be computed. *Damping index*: The minimum velocity and maximum velocity of the descending Hepatic vein flow are used to determine the damping index. We will gather the necessary data following the proforma. *Child-Pugh Score*: Total bilirubin, serum albumin, prothrombin time, ascites, and encephalopathy are used to compute the Child-Pugh Score.

Statistical analysis: Number, percentage, mean, and standard deviation were used to express the data. The mean and standard deviation were calculated using SPSS 20.0, which stands for Statistical Package for Social Sciences. MS Excel 2020 was used to calculate the number and percentage.

Results

Out of the total n=35 cases included in the study n=33(94.28%) were males and n=2(5.71%) were females. 60% of the cases in the study were in the age group of 51 to 60 years. Followed by 25.71% in the age group 61 – 70 years. The mean age of the cases in the study was 46.60 ± 5.56 years the details of the distribution of the cases in the study has been depicted in table 1.

Table 1: Number and percentage of patients based on age

Age (Years)	Males	Females	Frequency	Percentage (%)
30-40	1	0	2	05.71
41-50	4	0	5	14.28
51-60	18	1	21	60.00
61-70	8	1	9	25.71
> 70	2	0	3	08.57
Total	33	2	35	100.00

The mean size of the Liver in the cases of the study was 14.10 ± 1.51 cms and the mean size of the spleen in the case study was found to be 14.82 ± 1.92 cms. The liver echotexture was found to be increased in n=2(5.71%) cases and n=33(94.28%) cases were found to be with coarse echotexture. A total of n=30(85.71%) of cases were seen with ascites and n=5(14.28%) cases were without the presence of ascites. In the study cases, n=27(77.14%) cases were present with grade 0 encephalopathy and n=8(22.85%) cases were with grade 1 encephalopathy. The maximum number of patients in the study had a portal vein diameter of < 13mm during quiet respiration and n=19 cases had portal vein diameter > 13mm during deep respiration details depicted in table 2.

Table 2:Number of patients based on the diameter of portal vein on respiration

Portal vein measurement	*<13 mm*	*>13mm*	*Not measured*	*Total*
Portal vein diameter quiet respiration	18	14	3	35
Portal vein diameter deep respiration	12	19	4	35

In this study, n=30 cases had a portal vein diameter of < 20mm and >20mm in n=2 cases. Similarly, portal lumen size was normal in n=28 cases and flow status in the maximum number of cases was hepatopetal, No flow was detected in n=8 cases details depicted in table 3.

Table 3: Distribution of cases based on portal vein variation, lumen size, and flow rate

Portal Vein Lumen Variation				
Portal vein	*<20mm*	*>20mm*	*Not measured*	*Total*
Frequency	30	2	3	35
Portal Vein Lumen Size				
Lumen size	*Normal*	*Thrombosed*	*Cavernomatous transformation*	*Total*
Frequency	28	5	2	35
Portal Vein Lumen Flow Rate				
Flow Status	*Hepatofugal*	*Hepatopetal*	*To &Fro*	*No flow*
Frequency	1	25	1	8

In this study, the spleen size of more than 13 cms was noted in 82.85% of the patients. The mean spleen size was found to be 14.92 ± 2.52 cm distribution as depicted in figure 1. In maximum patients, 71.43% had >1cm Splenic vein diameter in quiet respiration and also deep respiration shown in figure 2.

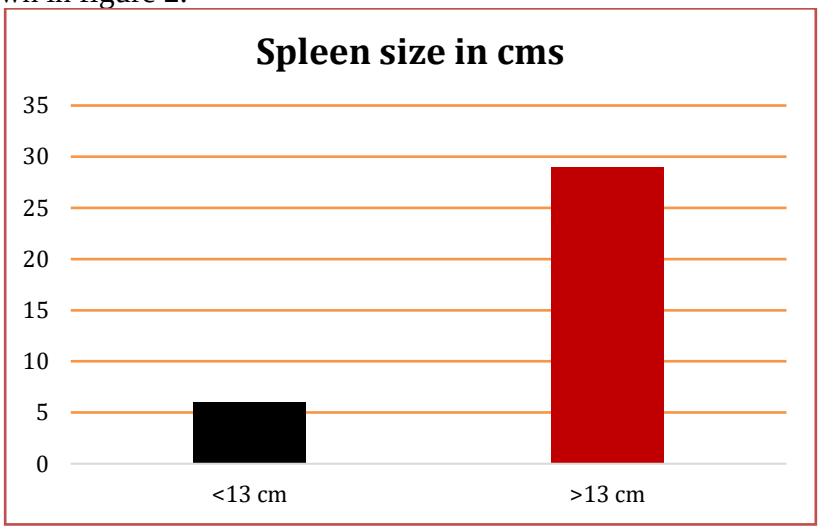

Figure 1: Distribution of cases based on the size of the spleen

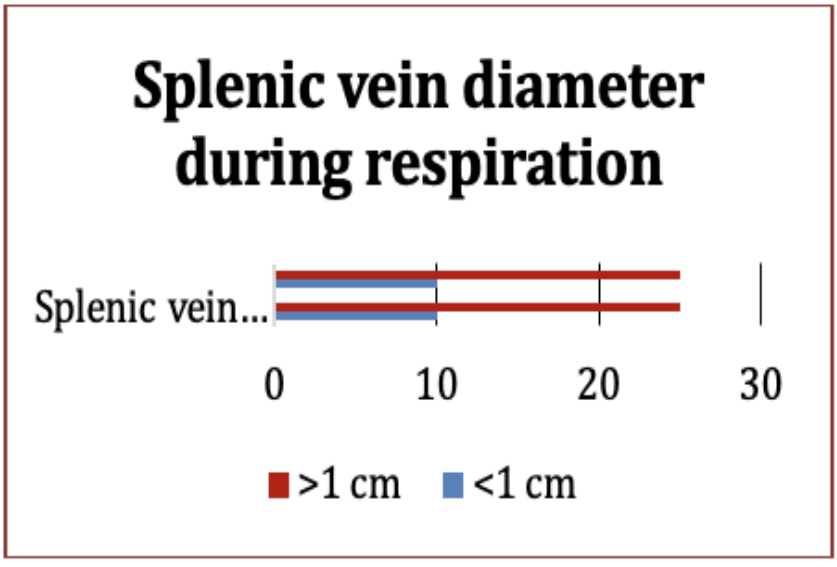

Figure 2: Distribution based on the diameter of splenic vein on respiration

In this study, n=33 cases had a portal vein diameter of <20mm and >20mm in n=2 cases. Similarly, splenic vein lumen size was normal in n=31 cases and flow status in the maximum number of cases n=30 was petal, and No flow was detected in n=4 cases details depicted in table 4.

Table 4: Distribution of cases based on splenic vein variation, lumen size, and flow rate

Portal vein	**<20mm**	**>20mm**	**Total**
Frequency	33	2	35
Lumen size	Normal	Thrombosed	Total
Frequency	31	4	35
Flow Status	Petal	To and Fro	No flow
Frequency	30	1	4

In this study based on the damping index of the hepatic vein the majority of patients (85.71%) presented with <0.6 and (14.28%) had >0.6 damping index of the hepatic vein. In this study Child, Turcotte-Pugh class scores were recorded in each patient, and based on the scores they were distributed in Class A = 5 – 6 points (least severe liver disease), Class B 7 to 9 points (moderately severe liver disease), and class C 10 – 15 points (most severe liver disease) the detailed distribution of the scores and class is given in table 5.

Table 5: Distribution of cases based on Child Turcotte-Pugh score

Child Turcotte-Pugh score	**Frequency**	**Percentage**
Class A	6	17.14
Class B	11	31.43
Class C	18	51.42
Total	35	100.00

Based on the number of collaterals developed n=7(20.0%) cases had single collateral developed n=12(34.28%) cases had double collateral developed and n=15(42.86%) had more than double collaterals and n=1(2.86%) did not have any collaterals developed. The diagnosis of the cases in the study is given in figure 3. The correlation between the Child Turcotte-Pugh score and damping index is given in table 6.

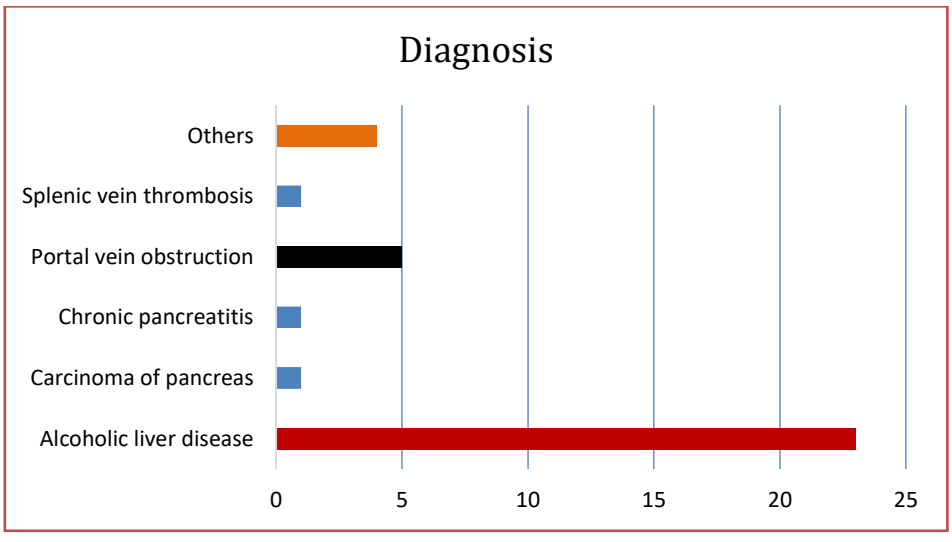

Figure 3: Distribution of cases based on diagnosis

Table 6: Correlation of child-pugh score and damping Index

Child pugh score	Frequency	Percentage	Damping index (Mean ± SD)	Range
Class A	6	17.14	0.26±0.19	0.21-0.34
Class B	11	31.43	0.35±0.16	0.32-0.60
Class C	28	51.42	0.66±0.15	0.61-0.85

Discussion

In cirrhotic conditions, portal hypertension is a common development. It results from obstruction of the portal vein and can cause ascites and variceal hemorrhage, among other problems. Portal hypertension is a significant factor in the development of serious consequences and death in cirrhotic patients. The objective is to identify and assess the severity of portal hypertension to reduce potentially serious and fatal consequences. Hepatic and portal hemodynamics can be non-invasively investigated using Doppler ultrasonography. As a result, numerous attempts to measure portal hypertension in cirrhotic patients using Doppler ultrasonography have been made. [7] Doppler ultrasonography's assessment of hepatic vein (HV) waveform alteration may be useful for detecting portal hypertension in cirrhotic individuals. [8] As a result of cardiac fluctuations in central venous pressure, the Doppler HV waveform in healthy individuals is typically triphasic (two negative waves and one positive wave). [9, 10] It is well known that cirrhosis and portal hypertension causes the typical triphasic HV Doppler waveform to change into a biphasic or monophasic waveform. 68 Calculating the damping index (DI) enables measurement of the extent of the aberrant HV waveform (loss of pulsatility). [11] In the present study males outnumbered females i.e., n=33(94.28%) were males and n=2(5.71%) were females. A similar study done by Kim MY et al., [12] found that 77.3% of the male and 22.7% of females in a study of Doppler sonography is a parameter of severe portal hypertension. More than 60% of patients with cirrhosis and chronic liver disease are men, proving that liver disease has a sex preference. However, alcohol intake causes cirrhosis and portal hypertension and a higher incidence in men may be the cause. In this study, 60% of the cases in the study were in the age group of 51 to 60 years. Followed by 25.71% in the age group 61 – 70 years with a mean age of 46.60 ± 5.56 years. Goel A et al., [13] in a similar study in South India found the reported mean age as 46 years agreeing with the observations of this study. Gibson et al., [14] found that splenomegaly is an intensive sign of portal hypertension. In this study spleen size of more than 13 cms was noted in 82.85% of the patients. These findings are in agreement with various studies done in this field. [14, 15]Ditchfield et al., [14] reported that 59% of the patients with spleen size of > 13 cm. Gibson et al reported that 52% of patients had enlarged spleen on sonography. A study by Bolondi et al., [16] concluded that portal vein diameter > 13 mm can be considered a fairly characteristic sign of portal hypertension. The same was true in this study with almost 50% of the patients having a portal vein diameter of ≥ 13 mm. Portal hypertension can be detected when there is a less than 20% increase in the PV's diameter with deep inspiration. 35 Similar results were seen in this investigation, where 80% of patients had a 20% fluctuation in the width of their portal vein. In this study, 65.71% were diagnosed with alcoholic liver disease, and most of them with cirrhosis the other diagnosis is mentioned in figure 3. A recent study by Kim et al., [17] to correlate damping index and the hepatic venous pressure gradient reported 51.42% of the patients with alcohol as etiology of cirrhosis. In our study, alcoholic liver disease as the predominant cause of liver cirrhosis could be attributed to the high prevalence of alcohol consumption in the geographic region where the study was undertaken. In our study, 52.5% of the patients had a grade C Child-Pugh score. The mean damping index in patients with grade C child Pugh score was high (0.66 ± 0.15) compared to patients with grade B (0.35 ± 0.16) and grade A child Pugh score (0.26 ± 0.19). Further, the

comparison of mean damping scores for the patients with Child-Pugh scores grade A and B, Grade A and C, and Grade B and C showed a statistically significant difference ($p<0.001$). These findings suggest a significantly increasing trend of mean damping index scores with higher grades of Child-Pugh score ($p<0.001$).

Conclusion

Portal hypertension and its complications account for significantmorbidity and mortality. Ultrasonography with added color Doppler helps inevaluating portal hypertension and differentiation of sinusoidal, pre or postsinusoidal causes of portal hypertension. The Colour Doppler also offers accurate information in locating and defining the portal vein in patients with portal hypertension and aids in determining the presence of various portosystemic collaterals. The severity of liver impairment as measured by the Child Turcotte Pugh score and the hepatic vein damping index (DI) are closely correlated.

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