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Original Research Article

Role of color doppler in evaluation of portal hypertension

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ABSTRACT

Aim: Role of color doppler in evaluation of portal hypertension.

Material and methods: All the patients visiting the institution during the study period with clinical features that is suggesting towards the portal hypertension are included in the study. We had included 50 patients and 50 subjects in our study. GE Voluson S8 USG Machine, and LOGIC P9 USG Machine Siemens Acuson 300 USG Machine curvilinear array low frequency (2-5 MHz) and linear array high frequency (5- 13MHz) transducer was used.

Results: The mean damping index in Class A patients was 0.56 ± 0.09, in Class B patients, it was 0.61 ± 0.05 and in Class C patients, it was 0.65 ± 0.03. The comparison of mean damping index among the Child Pugh Scores was done using One-Way ANOVA, which was found to be statistically significant (F value = 10.598, P value = 0.001), which shows that there is a significant variation in the mean damping index among the Child Pugh Scores. The mean damping index was lowest in Class A and highest in Class C. With the increase in the Child Pugh Score, the mean damping index also increases.

Conclusion: Child Pugh Score when conjunct with damping index can effectively predict the prognosis patient. Color doppler successfully recognized each of these traits.

Keywords: Color doppler , Portal hypertension, Child Pugh Score

1. INTRODUCTION

Portal hypertension is the hemodynamic abnormality frequently associated with chronic liver disease, although it is recognized less commonly in a variety of extrahepatic diseases also. Portal hypertension is a major contributing factor and is associated directly with most lethal consequences of liver disease. The causes of the persistently rising prevalence of Chronic liver disease include Obesity, Chronic alcoholism, Hepatitis B and Hepatitis C.[1,2] Liver cirrhosis is the most prevalent cause of portal hypertension in the Western world. However, schistosomiasis is the most frequent cause in the African continent where schistosomiasis is endemic.[3] Portal hypertension can be sinusoidal, presinusoidal and post sinusoidal, accurate diagnosis by imaging modality can help in prompt treatment. In majority of cases portal hypertension is seen as one of the major complications of liver cirrhosis. It can further lead to life threatening complications like variceal bleeding hepatic encephalopathy ascites. So accurate diagnosis helps in timely implementation of surgical and medical management and thus prevents complication.

Due to its non-invasiveness, rapidity, and high sensitivity and specificity, ultrasound techniques like color doppler imaging are the modality of choice in imaging portal hypertension and it helps in differentiating the sinusoidal, pre or post sinusoidal factors leading to portal hypertension, in addition it also allows to look for sequelae like portal vein thrombosis, esophageal varices with reasonable accuracy.[1,2] Considering these advantages, the present study will be undertaken to evaluate the spectrum of color doppler sonographic findings in portal hypertension patients' and to measure hepatic vein damping index (DI) and correlation with severity of liver dysfunction (Child Pugh score)and also to evaluate the ability of this modality to compare portal hypertensive from non portal hypertensive.

2. MATERIAL AND METHODS

The present study was conducted in the Department of Radiodiagnosis, Index Medical College, Hospital and Research Center, Indore (M.P.) It was a cross-sectional and observational study. All the patients visiting the institution during the study period with clinical features that is suggesting towards the portal hypertension are included in the study. We had included 50 patients and 50 subjects in our study. The synopsis of the present research study was given to the Ethics Committee of the institution for review. After obtaining their approval, the present study was started in the institution.

GE Voluson S8 USG Machine, and LOGIC P9 USG Machine Siemens Acuson 300 USG Machine curvilinear array low frequency (2-5 MHz) and linear array high frequency (5-13MHz) transducer was used.

Inclusion Criteria

- All referred cases with clinical suspicion of portal hypertension.
- All cases with altered biochemical markers suggestive cirrhosis with portalhypertension.

Exclusion Criteria

- Patient not willing to give consent
- Pregnant women
- Patient presenting with trauma

3. METHODOLOGY

All the patients referred from OPD / IPD are included in study. They thoroughly explained about the study in detail in their own language. After obtaining the written consent study is started which includes ultrasonography (both grey scale and color doppler findings.) A customized proforma was designed for the specific requirement of the study, and all the relevant data was captured in that. The demographic characteristic of the study population such as age, sex of patient with clinical suspicion of chronic liver disease and portal hypertension, who were referred to the Department of Radiodiagnosis were noted. Clinical and lab findings include:- encephalopathy grading, ascites, total bilirubin, serum albumin, prothrombin time. Ultrasound (grey scale and color doppler finding) parameters that includes liver (size and echotexture) and spleen (size). In addition, the portal vein and splenic vein diameter (both during quiet and deep respiration), lumen size and flow volume, direction and velocity, presence and number of collaterals were noted. Hepatic vein evaluation was done using Damping index and Child Pugh score.

Statistical Analysis Plan

Comparison of means between two groups was done using Unpaired 't' test and between more than two groups was done using One-Way ANOVA. Association between two non-parametric variables was done evaluated using Pearson Chi-square test. A p value of <0.05 was taken as statistically significant. The final data was presented in astables and graphs.

4. RESULTS

Table No. 1: Distribution of patients according to groups

Group	Frequency (N)	Percentage (%)
Case Group (Group 1)	50	50.0
Control Group (Group 2)	50	50.0
Total	100	100.0

The above table shows the distribution of patients according to groups. There were 50 (50%) patients in each group.

Table No. 2: Distribution of patients according to age

Age	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
11-20 years	2	4.0	2	4.0
21-30 years	3	6.0	3	6.0
31-40 years	4	8.0	4	8.0
41-50 years	5	10.0	5	10.0
51-60 years	31	62.0	31	62.0
61-70 years	5	10.0	5	10.0
>70 years	5	10.0	5	10.0
Total	50	100.0	50	100.0
Mean age (±SD)	56.00 ± 9.33		56.00 ± 9.33	

't' value, df	0.000, df=98
P value	1.000, NS

The above table shows the distribution of patients according to age.
In Group 1, 2 (4%) patients were in age group 11-20 year, 3(6%) patients were in the age group 21-30, 4 (8%) patients were in the age group 31-40 years, 5 (10%) patients were in the age group 41-50 years, 31 (62%) patients were in the age group 51-60 years, 5 (10%) patients were in the age group 61-70 years and 5 (10%) patients were in the age group more than 70 years.
In Group 2, 2 (4%) patients were in age group 11-20 year, 3(6%) patients were in the age group 21-30, 4 (8%) patients were in the age group 31-40 years, 5 (10%) patients were in the age group 41-50 years, 31 (62%) patients were in the age group 51-60 years, 5 (10%). patients were in the age group 61-70 years and 5 (10%) patients were in the age group more than 70 years. The mean age of the patients in Group 1 was 56.00 ± 9.33 years and in Group 2, it was 56.00 ± 9.33 years. The mean age of the patients was comparable between the two groups(P=1.000).

Table No. 3: Distribution of patients according to sex

Sex	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Female	7	14.0	7	14.0
Male	43	86.0	43	86.0
Total	50	100.0	50	100.0

In Group 1, there were 7 (14%) females and 43 (86%) males. In Group 2, there were 7 (14%) females and 43 (86%) males. There was no statistically significant association between sex and the groups (P=1.000), which shows that the groups are not dependent on the sex of the patients. In both the groups, the distribution of patients according to sex was comparable. The patients in both the groups were age- and sex-matched.

Table No. 4: Distribution of patients according to liver size

Liver Size	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Shrunken (<12 cm)	39	78.0	0	0.0

Normal (≥ 12 cm)	11	22.0	50	100.0
Total	50	100.0	50	100.0

In Group 1, liver was shrunken in 39 (78%) patients and normal in 11 (22%) patients. In Group 2, liver was normal in 50 (100%) patients. There was a statistically significant association between liver size and the groups (P=0.001), which shows that the groups are dependent on the liver size. Abnormal liver size was seen only in Group 1 patients.

Table No. 5: Distribution of patients according to splenomegaly

Splenomegaly	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Present	39	78.0	0	0.0
Absent	11	22.0	50	100.0
Total	50	100.0	50	100.0

In Group 1, splenomegaly was present in 39 (78%) patients and absent in 11 (22%) patients. In Group 2, splenomegaly was absent in all 50 (100%). There was a statistically significant association between splenomegaly and the groups (P=0.001), which shows that the groups are dependent on splenomegaly. Splenomegaly was seen only in Group 1 patients.

Table No. 6: Mean liver and spleen size of the patients

Organ		**equency(N)**	**ean ± SD(cm)**	**'t' value**	**P value**
Liver	Group 1	50	11.87 ± 1.22	-10.908, df=98	0.001*
	Group 2	50	13.89 ± 0.47		
Spleen	Group 1	50	14.10 ± 1.78	14.244, df=98	0.001*
	Group 2	50	10.17 ± 0.79		

Liver: The mean liver size in Group 1 patients was 11.87 ± 1.22 cm and in Group 2 patients, it was 13.89 ± 0.47 cm. The mean liver size was significantly larger in Group 1 patients as compared to Group 2 patients (P=0.001). Spleen: The mean spleen size in Group 1 patients was 14.10 ± 1.78 cm and in Group 2 patients, it was 10.17 ± 0.79 cm. The mean spleen size was significantly larger in Group 1 patients as compared to Group 2 patients (P=0.001). In

Group 1, liver was significantly reduced in size and spleen was significantly increased in size, as compared to Group 2.

Table No. 7: Distribution of patients according to liver echotexture

Liver echotexture	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Coarse	47	94.0	0	0.0
Normal	3	6.0	50	100.0
Total	50	100.0	50	100.0

In Group 1, 47 (94%) patients had coarse liver echotexture and 3 (6%) patients had normal liver echotexture. In Group 2, 50 (100%) patients had normal liver echotexture. There was a statistically significant association between liver echotexture and groups (P=0.001), which shows that groups are dependent on the liver echotexture. All the patients in Group 2 had normal liver echotexture, while majority of the patients in Group 1 had coarse liver echotexture.

Table No. 8 Distribution of patients according to presence of ascites

Ascites	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Present	46	92.0	0	0.0
Absent	4	8.0	50	100.0
Total	50	100.0	50	100.0

In Group 1, in 46 (92%) patients, ascites was present, while in only 4 (8%) patients, ascites was absent. In Group 2, in 50 (100%) patients, ascites was absent. There was a statistically significant association between ascites and the groups (P=0.001), which shows that the groups are dependent on ascites. Ascites was present in only Group 1 patients.

Table No. 9 Distribution of patients according to encephalopathy grading

Encephalopathy Grading	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**

Grade 0	4	8.0	50	100.0
Grade I	8	16.0	0	0.0
Grade II	18	36.0	0	0.0
Grade III	20	40.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 4 (8%) patients were in encephalopathy Grade 0, 8 (16%) were in Grade I, 18 (36%) were in Grade II and 20 (40%) patients were in Grade III. In Group 2, 50 (100%) patients were in encephalopathy Grade 0. There was a statistically significant association between encephalopathy grading and the groups (P=0.001), which shows that the groups are independent of the encephalopathy grading. 92% patients in Group 1 had encephalopathy, while none of the patients of Group 2 had encephalopathy. Prevalence of higher grades of encephalopathy was seen in Group 1 patients.

Table No. 10: Distribution of patients according to diameter of portal vein on respiration

Portal Vein	**Group**	**<13 mm**	**≥13 mm**	**Could not be evaluated**	**Total**	**$\chi 2$ value**	**P value**
Portal vein	Group 1	29	21	0	50	26.582,	0.001*
diameter (Quiet		58%	42%	0.0%	100%	df=1	
respiration)							
	Group 2	50	0	0	50		
		100%	0.0%	0.0%	100%		
Portal vein	Group 1	36	14	0	50	56.25,	0.001*
diameter (Deep		72%	28%	0.0%	100%	df=1	
respiration)							
	Group 2	0	50	0	50		
		0.0%	100%	0.0%	100%		

The above table shows the distribution of patients according to portal vein diameter both in Quiet and Deep respiration.

In Group 1, 29 (58%) patients had portal vein diameter <13 mm and 21 (42%) patients had

portal vein diameter ≥ 13 mm. In Group 2, 50 (100%) patients had portal vein diameter <13 mm. There was a statistically significant association between portal vein diameter (Quiet respiration) and the groups (P=0.001), which shows that the groups are dependent on the portal vein diameter (Quiet respiration). The prevalence of ≥ 13 mm portal vein diameter (quiet respiration) was higher in Group 1patients, as compared to the Group 2 patients.

In Group 1, 36 (72%) patients had portal vein diameter <13 mm and 14 (28%) patients had portal vein diameter ≥ 13 mm. In Group 2, 50 (100%) patients had portal vein diameter ≥13 mm. There was a statistically significant association between portal vein diameter (Deep respiration) and the groups (P=0.001), which shows that the groups are dependent on the portal vein diameter (Deep respiration). The prevalence of ≥ 13 mm portal vein diameter (deep respiration) was significantly less in Group 1 patients, as compared to the Group 2 patients.

Table No. 11: Mean diameter of portal vein in respiration

Portal Vein	**Group**	**equency(N)**	**Mean ± SD**	**'t' value, df**	**P value**
Quiet respiration	Group 1	50	12.91 ± 1.24	12.452, df=98	0.001*
	Group 2	50	10.18 ± 0.92		
Deep respiration	Group 1	50	13.06 ± 0.91	-4.226, df=98	0.001*
	Group 2	50	13.65 ± 0.37		

The above table shows the comparison of mean portal vein diameter (quiet respiration), mean portal vein diameter (deep respiration) and percentage of variation of portal vein diameter between the two groups.

Quiet respiration: The mean portal vein diameter in Group 1 was 12.91 ± 1.24 mm and in Group 2 was 10.18 ± 0.92 mm. The mean portal vein diameter (quiet respiration) was significantly higher in Group 1, as compared to Group 2 (P=0.001). Deep respiration: The mean portal vein diameter in Group 1 was 13.06 ± 0.91 mm and in Group 2 was 13.65 ± 0.37 mm. The mean portal vein diameter (deep respiration) was significantly higher in Group 2, as compared to Group 1 (P=0.001).

Table No. 12: Distribution of patients according to portal vein flow

Portal Vein Flow	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Hepatofugal	33	66.0	0	0.0

Hepatopetal	13	26.0	50	100.0
To & Fro	0	0.0	0	0.0
No flow	4	8.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 33 (66%) patients had hepatofugal type of flow, 13 (26%) patients had hepatopetal type of flow and in 4 (8%) patients, there was no flow noted. In Group 2, 50 (100%) patients had hepatopetal type of flow. There was a statistically significant association between the portal vein flow and the groups (P=0.001), which shows that the groups are dependent on the portal vein flow.

Table No. 13: Distribution of patients according to lumen of portal vein

Lumen of Portal Vein	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Normal	42	84.0	50	100.0
Thrombus	4	8.0	0	0.0
CVT	4	8.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 4 (8%) patients showed thrombus in the lumen of portal vein and 4 (8%) patients showed CVT in the lumen of portal vein. In 42 (84%) patients, the lumen of the portal vein was normal. In Group 2, all 50 (100%) patients had normal lumen of the portal vein. There was a statistically significant association between lumen of portal vein and the groups (P=0.013), which shows that the groups are dependent on the lumen of portal vein.

Table No. 14: Distribution of patients according to diameter of splenic vein on respiration

Splenic Vein	**Group**	**<10 mm**	**≥10 mm**	**Could not be evaluated**	**Total**	**$\chi 2$ value**	**P value**
Splenic vein	Group 1	27	23	0	50	29.870,	0.001*
diameter (Quiet		54%	46%	0.0%	100%	df=1	
respiration)							

	Group 2	50	0	0	50		
		100%	0%	0.0%	100%		
Splenic vein	Group 1	36	14	0	50	56.250 ,	0.001*
diameter (Deep		72%	28%	0.0%	100%	df=1	
respiration)							
	Group 2	0	50	0	50		
		0.0%	100%	0.0%	100%		

Quiet Respiration: In Group 1, 27 (54%) patients had splenic vein diameter <10 mm and 23 (46%) patients had splenic vein diameter ≥ 10 mm. In Group 2, 50 (100%) patients had splenic vein diameter <10 mm. There was a statistically significant association between splenic vein diameter (Quiet respiration) and the groups (P=0.001), which shows that the groups are dependent on the splenic vein diameter (Quiet respiration).
Deep Respiration: In Group 1, 36 (72%) patients had splenic vein diameter <10 mm and 14 (28%) patients had splenic vein diameter ≥ 10 mm. In Group 2, 50 (100%) patients had splenic vein diameter ≥10 mm. There was a statistically significant association between splenic vein diameter (Deep respiration) and the groups (P=0.001), which shows that the groups are dependent on the splenic vein diameter (Deep respiration). The prevalence of ≥ 10 mm splenic vein diameter (deep respiration) was significantly higher in Group 2 patients, as compared to the Group 1 patients.

Table No. 15: Mean diameter of splenic vein in respiration

SplenicVein	Group	Frequency (N)	Mean ± SD	't' value, df	P value
Quiet respiration	Group 1	50	10.08 ± 0.98	4.952, df=98	0.001*
	Group 2	50	9.34 ± 0.38		
Deep respiration	Group 1	50	10.32 ± 1.42	-13.926, df=98	0.001*
	Group 2	50	13.22 ± 0.38		

The above table shows the comparison of mean splenic vein diameter (quiet respiration), mean splenic vein diameter (deep respiration) and percentage of variation of splenic vein diameter between the two groups.
Quiet respiration: The mean splenic vein diameter in Group 1 was 10.08 ± 0.98 mm and in Group 2 was 9.34 ± 0.38 mm. The mean splenic vein diameter (quiet respiration) was significantly higher in Group 1, as compared to Group 2 (P=0.001). Deep respiration: The mean splenic vein diameter in Group 1 was 10.32 ± 1.42 mm and in Group 2 was 13.22 ± 0.38 mm. The mean splenic vein diameter (deep respiration) was significantly higher in Group 2,

as compared to Group 1 (P=0.001).

Table No. 16 Distribution of patients according to lumen of splenic vein

Lumen of Splenic Vein	Group 1		Group 2	
	equency(N)	rcentage(%)	equency(N)	rcentage(%)
Normal	50	100.0	50	100.0
Thrombus	0	0.0	0	0.0
CVT	0	0.0	0	0.0
Total	50	100.0	50	100.0

The above table shows the distribution of patients according to lumen of splenic vein. In Group 1, all 50 (100%) patients had normal lumen of the splenic vein. In Group 2, all 50 (100%) patients had normal lumen of the splenic vein. The test of association could not be applied as one of the variables was a constant.

Table No. 17 Distribution of patients according to splenic vein flow

Splenic Vein Flow	Group 1		Group 2	
	Frequency (N)	Percentage (%)	Frequency (N)	rcentage(%)
Hepatofugal	0	0.0	0	0.0
Hepatopetal	50	100.0	50	100.0
To & Fro	0	0.0	0	0.0
No flow	0	0.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 50 (100%) patients had hepatopetal type of flow. In Group 2, 50 (100%) patients had hepatopetal type of flow. The test of association could not be applied as one of the variables was a constant.

Table No. 18 Distribution of patients according to damping index of hepatic vein

Damping Index of Hepatic	Group 1	Group 2

Vein	equency(N)	rcentage(%)	equency(N)	rcentage(%)
<0.6	10	20.0	50	100.0
≥0.6	40	80.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 10 (20%) patients had damping index of <0.6, while 40 (80%) patients had damping index of ≥0.6. In Group 2, 50 (100%) patients had damping index of <0.6. There was a statistically significant association between damping index of hepatic veins and the groups (P=0.001), which shows that the groups are dependent on the damping index of the hepatic veins. Majority of the patients of group 1 had damping index of ≥ 0.6.

Table No. 19 Distribution of patients according to Child Pugh Score

Child Pugh Score	Group 1		Group 2	
	equency(N)	rcentage(%)	equency(N)	rcentage(%)
No grade	0	0.0	50	100.0
Class A	12	24.0	0	0.0
Class B	18	36.0	0	0.0
Class C	20	40.0	0	0.0
Total	50	100.0	50	100.0

In Group 1, 12 (24%) patients were in Class A, 18 (36%) patients were in Class B and 20 (40%) patients were in Class C.

Table No. 20. Association between Child Pugh Class and Portal Vein Flowin Group 1 patients

Portal Vein Flow	Child Pugh Class			Total
	Class A	Class B	Class C	
Hepatofugal flow	5 15.2%	11 33.3%	17 51.5%	33 100.0%

No flow	0 0.0%	3 75.0%	1 25.0%	4 100.0%
Hepatopetal flow	7 53.8%	4 30.8%	2 15.4%	13 100.0%
Total	12 24.0%	18 36.0%	20 40.0%	50 100.0%

Of the 33 patients showing hepatofugal flow in the portal vein, 5 (15.2%) were in Class A, 11 (33.3%) were in Class B and 17 (51.5%) were in Class C. Of the 13 patients showing hepatopetal flow in the portal vein, 7 (53.8%) were in Class A, 4 (30.8%) were in Class B and 2 (15.4%) were in Class C. There was a statistically significant association between portal vein flow and the Child Pugh Class (P=0.017), which shows that Child Pugh Class is dependent on the portal vein flow in Group 1 patients. The prevalence of hepatofugal flow was highest in Child Pugh Class C, while hepatopetal flow was highest in Class A. With the increase in the Child Pugh Class from A to C, the prevalence of hepatofugal flow increases.

Table No. 21 Distribution of patients according to number of collaterals

Number of Collaterals	**Group 1**		**Group 2**	
	equency(N)	**rcentage(%)**	**equency(N)**	**rcentage(%)**
Single	8	16.0	0	0.0
Double	39	78.0	0	0.0
Above double	3	6.0	0	0.0
No collaterals	0	0.0	50	100.0
Total	50	100.0	50	100.0

In Group 1, 8 (16%) patients had single collateral, 39 (78%) patients had double collaterals and 3 (6%) patients had more than two collaterals. In Group 2, none of the patients had any collaterals. There was a statistically significant association between collaterals and the groups(P=0.001), which shows that the groups are dependent on the collaterals.

Table No. 22 Distribution of patients according to type of collaterals

Type of Collaterals	Group 1		Group 2	
	equency(N)	rcentage(%)	equency(N)	rcentage(%)
SR	8	16.0	0	0.0
SR, GEJ	39	78.0	0	0.0
SR, GEJ, PU	3	6.0	0	0.0
No collaterals	0	0.0	50	100.0
Total	50	100.0	50	100.0

The above table shows the distribution of patients according to type of collaterals. In Group 1, SR collateral was seen in 8 (16%) patients, SR, GEJ collaterals was seen in 39 (78%) patients and SR, GEJ, PU collaterals was seen in 3 (6%) patients. In Group 2, none of the patients had any collaterals. There was a statistically significant association between type of collaterals and the groups (P=0.001), which shows that the groups are dependent on the type of collaterals.

Table No. 23 Distribution of patients according to etiology

Etiology	Group 1		Group 2	
	equency(N)	rcentage(%)	equency(N)	rcentage(%)
None	10	20.0	50	100.0
Alcoholic liver disease	36	72.0	0	0.0
Portal vein obstruction	4	8.0	0	0.0
Total	50	100.0	50	100.0

The above table shows the distribution of patients according to etiology. In Group 1, 36 (72%) patients had alcoholic liver disease and 4 (8%) patients had portal vein obstruction. In Group 2, none of the patients had any etiology.

Table No. 24 Association of Child Pugh Score and Damping Index in Group 1 patients

Child Pugh Score	No.	rcentage (%)	DampingIndex (mean±SD)	Range	F Value	P value
Class A	12	24.0	0.56 ± 0.09	0.39-0.67	10.598	0.001*
Class B	18	36.0	0.61 ± 0.05	0.49-0.69		
Class C	20	40.0	0.65 ± 0.03	0.61-0.69		
Total	50	100.0				

The above table shows the comparison of mean damping index in relation to Child Pugh Score in Group 1 patients. The mean damping index in Class A patients was 0.56 ± 0.09, in Class B patients, it was 0.61 ± 0.05 and in Class C patients, it was 0.65 ± 0.03. The comparison of mean damping index among the Child Pugh Scores was done using One-Way ANOVA, which was found to be statistically significant (F value = 10.598, P value = 0.001), which shows that there is a significant variation in the mean damping index among the Child Pugh Scores. The mean damping index was lowest in Class A and highest in Class C. With the increasein the Child Pugh Score, the mean damping index also increases.

5. DISCUSSION

The purpose of the current study was to assess the role and diagnostic efficacy of color doppler ultrasonography in the diagnosis of portal hypertension, measure the hepatic vein Damping Index (DI) to correlate it with the degree of liver dysfunction (Child Pugh Score) in patients with portal hypertension, and compare the results with patients without portal hypertension. 50 patients with portal hypertension (Group 1) and 50 controls (non-portal hypertensives)(Group 2) were enrolled in the present study.

The means ages were comparable between the two groups, and the majority of the patients in each group were between the ages of 51 and 60 years. In Prathyusha et al.[4] study, majority of the patients were in the age group of 51-65 years, and in Ahamed et al.[5] study, the mean age of the patients was 53.2 ± 11.4 years, which is comparable to our study findings. While a study done by Gibson et al.[6] showed a lower mean age in their patients (46 years).

There were 43 (86%) males and 7 (14%) females in both the groups. There is a male preponderance in both groups, but the distribution according to gender was comparable between the two groups. Bharathi et al.[7], Prathyusha et al.,[4] Shankar et al.[8] and Anda et al.[9] studies showed male predominance in their studies, which support our findings. Patients in Group 1 had a considerably higher prevalence of shrunken liver, while shrunken liver was not seen in Group 2 patients.

Splenomegaly was seen in 78% patients on Group 1 and none of the patients in Group 2. And this association was found to be statistically significant. Gibson et al. [6] in their found that splenomegaly is an intensive sign of portal hypertension and found a spleen size of more than 13 cm in 82.85% of their patients. In another study done by Ditchfield et al.[10] 59% of their

patients had a spleen size of more than 13 cm. The study results of these two authors corroborate with our study's findings, that in patients with portal hypertension, splenomegaly is a common finding. The only difference being that in our study, we used a cut-off of >12 cm to confirm the finding as splenomegaly, while these authors used a cut-off of >13 cm. Compared to Group 2 patients, Group 1 patients had significantly smaller mean liver sizes and significantly larger mean spleen sizes. The majority of Group 1 patients had ascites and a coarse liver echotexture, whereas none of the Group 2 patients did. When compared to patients in Group 2, ascites and coarse liver echotexture were considerably more common in Group 1 patients. Chakenahalli et al.[11] in their study reported ascites in 87.3%. In Prathyusha et al.[4] study ascites was seen in 77.5% patients, which corroborates with our study findings.

Encephalopathy Grade 0 (100%) was observed in all patients in Group 2, while Grade 1 (16%), Grade II (36%) and Grade III (40%) were observed in Group 1. Encephalopathy grade was substantially related to the groups. Only patients with portal hypertension exhibited higher grades of encephalopathy. Antil et al.[12] in their study reported encephalopathy grade 0 (4%), grade 1 (14%), grade 2 (38%), grade III (44%), which shows that patients with portal hypertension have higher grades of encephalopathy,which is similar to our finding.

In quiet respiration, most of the patients in Group 1 had portal vein diameter <13 mm (58%) and 21 (42%) patients had portal vein diameter $\geq$13 mm; while all the patients in Group 2 had portal vein diameter <13 mm (100%). In deep respiration, 14 (28%) patients had portal vein diameter $\geq$ 13 mm and 36 (72%) patients had portal vein diameter <13 mm; while all the patients in Group 2 had portal vein diameter $\geq$ 13 mm (100%). Study done by Ahamed et al.[13] reported that in cirrhotic patients with portal hypertension, the portal vein diameter was <13 mm in 44.5% patients in quiet respiration and >13 mm in 67.3% patients in deep respiration in case group, which is contrary to our study findings. The reason for this difference could not be identified.

In quiet respiration state, the mean portal vein diameter in Group 1 was 12.91 ± 1.24 mm and in Group 2, it was 10.18 ± 0.92 mm. The mean portal vein diameter in quiet respiration state was significantly higher in Group 1 than Group 2. In deep respiration state, the mean portal vein diameter in Group 1 was 13.06 ± 0.91 mm and in Group 2, it was 13.65 ± 0.37.
The mean portal vein diameter in deep respiration state was significantly lower in Group 1 than Group 2. Patients in Group 1 showed hepatofugal (66%), hepatopetal (26%) and no flow (8%) patterns of portal vein flow, while all patients of Group 2 (100%) showed hepatopetal type of portal vein flow. This association was found to be statistically significant. Abnormal portal vein flow (hepatofugal) was seen in Group 1 patients, while all the patients in Group 2 had normal portal vein flow towards the liver. Von Herbay et al.[14] showed normal portal vein flow in 73%, hepatofugal in 9% and bidirectional flow in 6% patients.

When compared to the patients in Group 2, we observed a significantly higher proportion of CVT (8%) and thrombus (8%) in Group 1 patients. The portal vein lumen of all patients in Group 2 was normal. In Bharathi et al.[11] study also, portal vein lumen was thrombosed in 14.3% and cavernomatous transformation was seen in 6% cirrhotic patients with portal hypertension. In Chakenahalli et al.[7] study, cavernoma was seen in 7.9% patients and thrombus in 14.3% patients. In our study also we found thrombosis and CVT in cirrhotic patients with portal hypertension, but the prevalence was less as comparedto these studies.

In our study, in quiet respiration state, the prevalence of splenic vein diameter of <10 mm was 54% and ≥10 mm was 46% in Group 1, while all the Group 2 patients had a splenic vein diameter of <10 mm (100%). In deep respiration state, 36 (72%) patients in Group 1 had splenic vein diameter <10 mm and 14 (28%) patients had splenic vein diameter ≥10 mm, while all the patients of Group 2 had splenic vein diameter ≥10 mm (100%) in deep respiration state. The study done by Bharathi et al.[11] showed that most of the cirrhotic patients had splenic vein diameter <10 mm (62.85%) in quiet respiration, while most of the patient had splenic vein diameter >10 mm (84.43%) in deep respiration state. Our study results partially match with the study done by Bharathi et al.[11] that most of the patients have splenic vein diameter <10 mm in quiet respiration, but did not match the findings of deep respiration. The reason for this difference could not be identified.

In quiet respiration state, the mean splenic vein diameter in Group 1 was 10.08 ± 0.98 mm and in Group 2, it was 9.34 ± 0.38 mm. The mean splenic vein diameter in quiet respiration state was significantly higher in Group 1 than Group 2. In deep respiration state, the mean splenic vein diameter in Group 1 was 10.32 ± 1.42 mm and in Group 2, it was 13.22 ± 0.38. The mean splenic vein diameter in deep respiration state was significantly lower in Group 1 than Group 2.

Splenic vein lumen was found to be normal in both the groups. (Table No. 16) Hepatopetal type of splenic vein flow was seen in both the groups. Our findings are similar to Bharathi et al.[11] who also reported 85.71% cirrhotic patients had hepatopetal flow pattern in the splenic vein. Damping index (≥ 0.6) was seen in 12% in Group 1 and 0% in Group 2 patients, which was statistically significant. Bharathi et al.[11] found Damping index of ≥ 0.6 in only 14.28% patients with portal hypertension and cirrhosis.

In Group 1, 24% were in Child Pugh Class A, 36% in Class B and 40% in Class C. In Mittal et al.[15] study, 26% patients were in Class A, 32% in Class B and 42% in Class C; in Bharathi et al.[11] study, 17.14% patients were in Class A, 31.43% in Class B and 51.42% in Class C; in Nouh et al.[16] study, 19.4% patients were in Class A, 34.3% were in Class B and 46.3% were in Class C; and in Antil et al.[12] study, 3.33% patients were in Child A, 20% were in Class B and 76.7% were in Class C, which is similar to our study findings. The majority of the patients with portal hypertension have severe disease condition. Higher prevalence of alcoholic liver disease (72%) was seen in Group 1, while no etiology was seen in Group 2 patients. The mean Damping Index was highest in Class C and lowest in Class A patients in Group 1. Mean damping index increases with the increase in Child Pugh score. Our findings are supported by Bharathi et al.[11] study, who also reported highest damping index in Class C and lowest in Class A in cirrhotic patients with portal hypertension.

6. CONCLUSION

Shrunken liver (altered coarse echotexture) with splenomegaly, ascites, prominent portal and splenic vein, presence of collaterals and deranged lab reports are hallmarks of portal hypertension patients with portal hypertension experiences the higher grades of encephalopathy. Child Pugh Score when conjunct with damping index can effectively predict the prognosis patient. Color doppler successfully recognized each of these traits.

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