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Original Research Article

CORRELATION OF PORTAL VEIN DIAMETER AND SPLEEN SIZE WITH GASTRO- OESOPHAGEAL VARICES IN PATIENTS WITH CIRRHOSIS OF LIVER- A HOSPITAL BASED CROSS SECTIONAL STUDY

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Abstract

Background: The Portal hypertension, a common and serious complication of liver cirrhosis, is defined by an increase in the hepatic venous pressure gradient (HVPG) to greater than 5 mmHg. Increased resistance to portal blood flow, due to altered hepatic architecture in cirrhosis, leads to the dilation of the portal vein and splenomegaly. One of the most life-threatening outcomes of portal hypertension is variceal bleeding. Only few studies have shown that portal vein diameter and spleen size measured by ultrasonography are associated with the development of varices. This study aims to determine the correlation between portal vein diameter, spleen size, and the presence and severity of gastroesophageal varices in patients with cirrhosis of the liver. **Materials and Methods:** This is a hospital based cross sectional study conducted at Regional Institute of Medical Sciences, RIMS, Imphal for a period of two years from May 2022 to September 2024. Patients who were diagnosed cirrhosis with portal hypertension of age 18 years and above, attending Medicine OPD, Gastroenterology OPD and patients admitted in Medical wards, RIMS were included in the study. Routine investigations - Complete haemogram, Liver function test, Kidney function test, Prothrombin time (PT), international normalised ratio (INR), Ultrasonography of whole abdomen and Upper Gastrointestinal (UGI) Endoscopy were done for every patients. A p- value <0.05 was considered statistically significant. **Result:** A total of 107 patients were enrolled with most of them belonging to age group 46-55 years (37, 34.58%) and majority males (104, 61.12%). A majority of 40 patients (37.39%) exhibit increased spleen sizes between 13.01 cm and 16.0 cm. Most of the study subjects (61, 57.01%), exhibit normal portal vein diameters (PVD) ranging from 10.1 mm to 13.0 mm. Maximum participants (45, 42.06%) had large varices (diameters exceeding 10 mm) on UGI endoscopy. There were statistically significant positive correlation between the size of the spleen with PVD and grading of esophageal varices (p-value<0.05). Thus, as the spleen size increases, size of PVD and grading of esophageal varices increases. However, there was no significant differences in PVD among the different grades of EV(F = 0.737, P = 0.532), suggesting that the mean PVD does not vary significantly across the different grades of esophageal varices. **Conclusion:** The present study concluded that as the grading of esophageal varices increases from small to very large, there is a notable trend in spleen enlargement. This study reinforces the importance of non-invasive parameters such as spleen size and, to a lesser extent, portal vein diameter in assessing gastroesophageal varices in cirrhotic patients. The findings of this study may help identify high-risk patients who require endoscopic screening and guide the management of cirrhosis complications.

INTRODUCTION

Cirrhosis of the liver, the end-stage of chronic liver disease, is characterized by significant alterations in liver architecture, including widespread nodule formation, vascular reorganization, neo-angiogenesis and extracellular matrix deposition. At the cellular level, fibrosis and cirrhosis are driven by the recruitment of stellate cells and fibroblasts, leading to fibrotic tissue formation, while parenchymal regeneration relies on hepatic stem cells. Variceal hemorrhage, a severe and potentially fatal complication of cirrhosis, remains a leading cause of mortality and morbidity among affected patients.[1] Portal hypertension is a common and serious complication of liver cirrhosis, defined by an increase in the hepatic venous pressure gradient (HVPG) to > 5 mmHg.[2,3] This condition arises from a combination of increased resistance to blood flow within the liver, due to cirrhotic changes and regenerative nodules, and splanchnic vasodilation that leads to increased blood flow.[4] Variceal bleeding particularly from esophageal and gastric varices is one of the dreaded most life-threatening complication of portal hypertension.[2] These varices are abnormal, dilated veins that form in the esophagus or stomach due to increased blood flow and pressure in the portal venous system.[5] Therefore, early detection and monitoring of varices are crucial for the management of cirrhosis patients. Portal vein has a unique role in the body's circulatory system. Unlike typical veins that drain blood directly to the heart, the portal vein transports blood from the capillaries of the intestinal wall and spleen to the hepatic sinusoids. This blood, rich in metabolic substrates, undergoes the first-pass effect in the liver, where ingested substances are processed before entering the systemic circulation (first-pass effect).[6] This distinctive feature underlines the importance of the portal vein in maintaining metabolic homeostasis.

Increased resistance to portal blood flow, due to altered hepatic architecture in cirrhosis, leads to the dilation of the portal vein and splenomegaly. These changes are often accompanied by the formation of esophageal and gastric varices, which are major contributors to upper gastrointestinal (UGI) bleeding in cirrhotic patients. Varices develop as portosystemic collaterals, which are vascular channels linking the portal venous system to the systemic venous circulation. These collaterals emerge as a compensatory mechanism to decompress the heightened portal pressure.[7]

Endoscopy is the gold standard for diagnosing and grading gastroesophageal varices.[8] However, it is an invasive procedure that may not be suitable for all patients, especially those with advanced liver disease or coagulopathy. Additionally, endoscopy may not be readily available in all healthcare settings. Non-invasive methods, such as ultrasonography, have been explored as alternatives for predicting the presence and severity of gastroesophageal varices in cirrhosis patients. Studies have shown that portal vein diameter (PVD) and spleen size measured by ultrasonography (USG) are associated with the development of varices.

This study aims to determine the correlation between portal vein diameter, spleen size, and the presence and severity of gastroesophageal varices in patients with cirrhosis of the liver. The findings of this study may help identify high-risk patients who require endoscopic screening and guide the management of cirrhosis complications. Elucidating these relationships could contribute to improved clinical assessment and management strategies for individuals suffering from this debilitating condition.

MATERIALS AND METHODS

This is a cross sectional Hospital based study conducted in the Department of Medicine RIMS, Imphal for a period of two years from May 2022 to September 2024. Patients who were diagnosed cirrhosis of liver with portal hypertension attending Medicine OPD, Gastroenterology OPD and admitted in department of Medicine were enrolled.

Inclusion criteria included patients of aged 18 years and above, diagnosed cirrhosis with portal hypertension and who had given consent to participate in the study.

Exclusion criteria included patients with advanced cirrhosis (Child-Pugh class C), Human Immuno deficiency Virus (HIV) infection, Hepatocellular carcinoma (HCC), portal vein thrombosis, current alcohol use, severe or unstable cardiovascular disease and pulmonary disease, active gastro-intestinal tract bleeding and who have done endoscopic band ligation (EBL). Splenomegaly secondary to tropical infection, blood dyscrasia, neoplastic causes and those not willing to give consent were excluded.

The sample size was calculated using the formula:

n =4 x PQ/L2, where n = sample size, P =Prevalence of esophageal varices in cirrhotic patients as 68%, from a study done by Mohanty R, Mohapatra N, Malla A, et al,[3]

L= Absolute Allowable error = 9. Therefore, n= 4x 68(100-68)/92=107.

Study Procedure: A predesigned performa which included clinical features, past history, general physical examination after informed consent, were recorded for every patient. Routine investigations included complete haemogram, random blood sugar (RBS), liver function test (LFT), kidney function test (KFT), prothrombin time (PT) and international normalised ratio (INR). Ultrasonography of whole abdomen for measurememt of PVD and splenic size and UGI Endoscopy were done for every patient.

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Working definition

Size of the spleen: It is measured by using 6-12 MHz USG in the coronal plane posteriorly in supine position. The average adult spleen measure: 10-11 cm in length The maximum cephalocaudal measurement exceeding 13 cm indicates splenic enlargement.

Portal vein diameter measurement: It is measured where the portal vein crosses inferior vena cava anteriorly. In normal persons, PVD does not exceed 13 mm in quiet respiration

Upper GI endoscopy: Grading of EV.[7]

- Grade-I- Small varices without luminal prolapse.
- Grade-II- Moderate-sized varices showing luminal prolapsed minimally obscuring the gastro-esophageal (GE) junction.
- Grade-III- Large varices with prolapsed of the lumen substantially obscuring the GE junction.
- Grade-IV- Very large varices completely obscuring the GE junction.

Statistical analysis: The data obtained will be analysed using SPSS version 26. Mean, median, SD, Student's t-test and chi square correlation coefficient were used for analysis. A p value <0.05 was considered statistically significant.

Approval of research ethics board: Ethical approval for this study was obtained from the Research Ethics Board, Regional Institute of Medical Sciences, Imphal [No.A/206/REB-Comm(SP)/RIMS/2015/895/233/2022].

RESULTS

A total of 107 patients with cirrhosis of liver with portal hypertension were enrolled. The baseline characteristics of the study subjects were shown in [Table 1] and parameters of liver function tests were given in [Table 2]. Most of the patients (37, 34.58%) belonged to age group are aged 46-55 and majority patients were males (104, 61.12%) while only 3 participants (38.89%) were females. Liver function tests in the present study showed increased total bilirubin (mean of 8.02±6.55), elevated SGOT (mean 112.40±96.86), elevated SGPT (mean of 56.63±39.33), hypoalbuminemia was found low in all patients (100%) with mean 2.35±0.48. Coagulopathy was present with mean PT of 19.25±5.25 and mean INR of 2.02±0.89. All the parameters were consistent with the alcoholic liver disease.Majority of the patients 94 (88.7%) had reversal of A:G ratio which is indicative of chronicity of the disease. USG abdomen shows features of liver parenchymal disease (cirrhosis) in 98(92.5%) and remaining had hepatomegaly with ascites. Majority of them (67%, 62.2%) had anemia with Hb 6-9.9g/dl and normal leucocyte count (69, 64.49%). Maximum participants (104, 97.2%) had thrombocytopenia (<150,000cells/μ L).

Among 107 patients, maximum study subjects 51(47.67%) have normal spleen sizes ranging from 10.0 cm to 13.0 ,40 patients (37.39%) exhibit spleen sizes 13.01 cm - 16.0 cm and 16 patients (14.96%) have spleen sizes ranging from 16.01 cm to 19.0 cm. Majority patients (61 patients,57.01%) had normal PVDs (10.1 mm - 13.0 mm),moderate dilatation present in 32 patients(29.91%) i.e. 13.1 mm-16.0 mm and significant dilation were also present: 7 patients (6.55%) have PVDs between 8.0 mm and 10.0 mm, while 4 patients (3.74%) range from 16.1 mm to 19.0 mm, and 3 patients (2.81%) exceed 19.0 mm. There was a weak but statistically significant positive correlation between the size of the spleen and PVD, as shown in [Table 3]. The Pearson correlation coefficient is 0.244, suggesting a slight positive linear relationship between spleen size and portal vein diameter. This correlation is statistically significant, with a p-value of 0.011 ($p < 0.05$), indicating that the observed relationship is unlikely to be due to random chance. Thus, as the spleen size increases, the PVD tends to increase slightly, demonstrating a meaningful association between these two variables.

It was observed that as the grading of esophageal varices increases from small to very large, splenic enlargement was observed. Specifically, the mean size of the spleen increases progressively across the variceal grades: 12.84 cm for small varices, 13.62 cm for moderate varices, 13.09 cm for large varices, and 14.57 cm for very large varices. The overall mean + SD size of the spleen is 13.48 + 1.93 cm. The test shows a statistically significant difference ($F = 3.51$, $P = 0.017$*) by ANOVA test, indicating that the mean size of the spleen varies significantly across the different grades of esophageal varices, which was shown in [Table 4].

The mean PVD are reported for different grades of EV: small varices (1.22 ± 0.12 cm), moderate varices (1.32 ± 0.24 cm), large varices (1.31 ± 0.25 cm), and very large varices (1.26 ± 0.26 cm). The overall mean PVD across all grades is 1.29 ± 0.24 cm. there was no significant differences in PVD among the different grades of EV ($F = 0.737$, $P = 0.532$), suggesting that the mean PVD does not vary significantly across the different grades of esophageal varices as shown in [Table 5].

Table 1: Baseline characteristics of the study subjects (N= 107)..

Characteristics	Study subjects (n, %)
Age (in years)	
25-35	5(4.68%)
36-45	29(27.1%)
46-55	37(34.58%)
56-65	30(28.04%)
66-75	6(5.6%)
Gender	

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Male	104(97.2%)
Female	3(2.8%)
Signs of liver dysfunction	
Hepatomegaly	7(6.5%)
Jaundice	11(10.3%)
Ascites	29(27.1%)
Hemorrhagic tendencies	2(1.9%)
Portal hypertension	38(35.5%)
Hepatic encephalopathy	2(1.9%)
Haemoglobin level (g/dl)	
6-9.9	67(62.2%)
10-12.9	35(32.72%)
13-15.9	5(4.68%)
Total leucocyte count (cell/µL)	
Low (<4000)	2(1.87%)
Normal (4000-10000)	69(64.49%)
High (>10000)	36(33.65%)
Platelet count (cells/µL)	
Low (<150,000)	104(97.2%)
Normal (150,000-450,000)	2(1.87%)
High(>450,000)	1(0.94%)
PT (seconds)	
Low (<12)	3(2.81%)
Normal (12-15)	78(72.90%)
High (>15)	26(24.30%)
INR	
Low(<1)	16(14.96%)
Normal (1-1.5)	61(57.01%)
High(>1.5)	30(28.04%)
Size of spleen (cm)	
10-13	51(47.67%)
13.01-16	40(37.39%)
16.01-19	16(14.96%)
Portal vein diameter(mm)	
8-10	7(6.55%)
10.01-13	61(57.01%)
13.1-16	32(29.91%)
16.1-19	4(3.74%)
>19	3(2.81%)
Grading of EV	
Small varices	13(12.15%)
Moderate varices	29(27.11%)
Large varices	45(42.06%)
Very large varices	20(18.70%)

Table 2: Liver function tests for the study subjects (N = 107).

Parameters	**Study patients (n,%)**
T.bilirubin (mg/dl)	
Low(<1)	3(2.81%)
Normal (1-1.2)	15(14.02%)
High (>1.2)	89(83.18%)
D.bilirubin (mg/dl)	
Low(<0.3)	15(14.02%)
Normal (0.3-1.2)	58(54.21%)
High (>1.2)	34(31.78%)
Albumin (g/dl)	
Low(<3.5)	93(86.92%)
Normal (3.5-5)	14(13.09%)
High (>5)	0(0%)
Globulin (g/dl)	
Low(<2)	13(12.15%)
Normal (2-4)	80(74.77%)
High (>4)	14(13.09%)
SGOT(U/L)	
Low(<40)	39(36.45%)
Normal (40-50)	23(21.50%)
High (>50)	45(42.06%)
SGPT (U/L)	
Low(<40)	83(77.58%)
Normal (40-60)	18(16.83%)
High (>60)	6(5.61%)
GGT (U/L)	
Low(<50)	40(37.39%)
Normal (50-70)	19(17.76%)
High (>70)	48(44.86%)

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ALP(U/L) Low(<100) Normal (100-150) High (>150)	 85(79.44%) 14(13.09%) 8(7.48%)

Table 3: Correlation of the size of the spleen and the diameter of the portal vein (N = 107).

Correlation Table	Mean±SD	ANOVA		Pearson's Correlation	
		F	P value	Pearson's R	P value
Size of the spleen	13.48±1.93	2.516	0.001**	0.244*	0.011*
Portal Vein Diameter	1.29±0.24				

*Correlation is significant at the 0.05 level (2-tailed).

Table 4: Correlation of the size of the spleen and esophageal varices (N = 107).

Grading of EV	Size of the spleen	F	P value
Small varices	12.84±1.58	3.51	0.017*
Moderate varices	13.62±2.09		
Large Varices	13.09±1.62		
Very large varices	14.57±2.19		
Total	13.48±1.93		

Table 5: Correlation of the diameter of the portal vein and esophageal varices (N = 107).

Grading of EV	Portal Vein Diameter	F	P value
Small varices	1.22±0.12	0.737	0.532
Moderate varices	1.32±0.24		
Large Varices	1.31±0.25		
Very large varices	1.26±0.26		
Total	1.29±0.24		

DISCUSSION

One of the hemodynamic characteristics of portal hypertension is the emergence of portal-collateral circulation. Collaterals formation is a complex process where pre existing vascular channels undergo dilatation, opening and hypertrophy. In response to the increased portal pressure, there is development of collaterals. Esophageal varices and portosystemic collaterals develop at a minimum threshold level of HVPG may be 10mm Hg.[9] The present study enrolled 107 cirrhotic patients with portal hypertension. Cirrhosis leads to alteration of liver architecture resulting in increased portal vein pressure, formation of varices and risk for fatal complication of variceal bleeding. This study highlighted the importance of detection of dilation of portal vein and splenomegaly as important non-invasive marker for development of varices.

Spleen size and portal vein: The distribution of spleen sizes among the patient sample shows that while majority of patients 51(47.67%) have normal spleen sizes ranging from 10.0 cm to 13.0 cm, 40 patients (37.39%) exhibit spleen sizes between 13.01 cm and 16.0 cm. Additionally, 16 patients (14.96%) have spleen sizes ranging from 16.01 cm to 19.0 cm. This data highlighted that a significant portion of the patients studied demonstrate spleen enlargement beyond the normal size range. The distribution of PVD among the patient sample reveals varying degrees of dilation. The majority, comprising 61 patients (57.01%), exhibit normal PVDs ranging from 10.1 mm to 13.0 mm,32 patients (29.91%) have moderate dilation PVDs between 13.1 mm and 16.0 mm. While more significant dilation were also seen: 7 patients (6.55%) have PVDs between 8.0 mm and 10.0 mm, while 4 patients (3.74%) range from 16.1 mm to 19.0 mm, and 3 patients (2.81%) exceed 19.0 mm. The study revealed a statistically significant positive correlation between spleen size and PVD (Pearson's r = 0.244, p = 0.011), suggesting that splenomegaly is associated with portal hypertension which was consistent with the studies by Berzigotti et al,[10] and Shah Zaman et al,[11] and Bhattarai etal.[12]ANOVA results confirmed significant differences in spleen size across various PVD (F(25, 81) = 2.516, p = 0.001).The underlying pathophysiology is that as portal hypertension develops in cirrhosis, it leads to splenomegaly and dilation of the portal venous system, including the main portal vein as per Prihartini J et al.[13] An increase in spleen size often accompanies an increase in PVD, which can be a useful non-invasive marker for the presence of portal hypertension and esophageal varices in cirrhotic patients.

Grading of EV: The distribution of patients according to the grading of esophageal varices (EV) reflects varying degrees of severity based on the size and appearance of the varices during endoscopic examination. Among the 107 patients analyzed, small varices are observed in 13 individuals (12.15%), indicative of early-stage variceal development characterized by small, tortuous veins typically <5 mm in diameter. Moderate varices are present in 29 patients (27.11%), representing varices ranging from 5 mm to 10 mm in diameter. Large varices, found in 45 patients (42.06%), denote further dilation and a higher risk of bleeding, with diameters exceeding 10 mm. The most severe cases, very large varices, are identified in 20 patients (18.70%), where varices are

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notably enlarged, often exceeding 15 mm in diameter and posing a significant risk of hemorrhage. This classification system helps clinicians assess the progression and severity of esophageal varices, guiding appropriate management strategies to mitigate the risk of complications such as variceal bleeding.

Spleen size and Esophageal varices: The grading of esophageal varices showed a significant trend of increasing spleen size with higher variceal grades. ANOVA results confirmed significant differences in spleen size across various esophageal varices grades ($F = 3.51$, $p = 0.017$).Patients with very large varices had the largest spleens, highlighting the relationship between advanced portal hypertension and splenomegaly. This finding is supported by the study of de Franchis et al,[14] which demonstrated that variceal size correlates with portal hypertension severity and hence could be useful as in chronic liver disease patients in prediction of esophageal varices.

Portal vein and Esophageal varices: In present study, the overall mean PVD across all grades was 1.29 ± 0.24 cm. There were no significant differences in PVD among the different grades of esophageal varices (EV) ($F = 0.737$, $P = 0.532$), indicating that there was no significant variation of mean PVD across EV of different grades. This finding was consistent with the studies by Luntsi et al,[6] in their study showed that the correlation between PVD and esophageal varices was weak, suggesting that while PVD increases with liver disease severity, it may not be a strong standalone predictor of varices. Similarly, Gaduputi et al,[5] and Berzigotti et al,[10] suggested that while PVD alone may not be a definitive predictor, its ratio with splenic vein diameter could be useful in identifying patients at risk for varices. Likewise, Sharma SK et al,[15] also reported that PVD was not significantly associated with the presence of varices. However, Mohanty et al,[3] reported a positive correlation between presence of esophageal varices and increased PVD and concluded that patients with varices had an average PVD of 13.46 ± 0.98 mm compared to 10.91 ± 0.65 mm in those without varices ($p=0.03$). Additionally, spleen size also correlated significantly with varices, supporting the idea that both PVD and spleen size can be used as a reliable and independent predictors of varices in cirrhotic patients, potentially reducing the need for routine endoscopic screening. This supported the notion that larger PVD was associated with an increased risk of varices. This discrepancy may be due to differences in patient populations, study designs, or measurement techniques. These studies collectively suggested that PVD may not be a reliable predictor of esophageal varices in patients with cirrhosis, and other factors should be considered in the diagnosis and management of these patients. The progressive nature of portal hypertension and its complications, as discussed by Bosch et al [16], underscores the importance of comprehensive monitoring.

Spleen size, Portal vein and Esophageal varices: This study observed that PVD > 13mm and a spleen size > 12 cm were significantly associated with the presence of esophageal varices and the combination of both parameters having a higher predictive value than either parameter alone, which was at par with the studies done by Garcia-Tsao et al,[17]Berzigotti et al[10] and Sharma etal.[15]

CONCLUSION

The present study highlights spleen size and portal vein diameter as important non-invasive makers in prediction of gastroesophageal varices in cirrhotic patients. A comprehensive approach integrating these parameters alongside clinical evaluation remains crucial for effective management and timely intervention in cirrhotic patients at risk of variceal bleeding. By enhancing our ability to identify high-risk individuals, non-invasive methods like ultrasonography offer a practical and accessible means to optimize patient care, potentially mitigating the serious consequences associated with variceal hemorrhage and improving overall outcomes in cirrhosis management.

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