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Platelet Count to Splenic Diameter Ratio as a Predictor of Esophageal Varices in Patients with Chronic Liver Disease

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KEYWORDS

Chronic liver disease, Esophageal varices, Platelet count, Splenic diameter, Non-invasive predictors, Portal hypertension.

ABSTRACT:

Background: Esophageal varices are a significant complication of chronic liver disease (CLD) and can lead to life-threatening hemorrhage. The gold standard for diagnosis is endoscopy, but this invasive procedure is not always accessible in resource-limited settings. This study evaluates the predictive value of platelet count to splenic diameter (PC) ratio as a non-invasive marker for esophageal varices in patients with CLD.

Methodology: This 18-months (May 1, 2023, to October 31, 2024) observational cross-sectional study included 156 patients with CLD in the General Medicine department at the National Institute of Medical Sciences & Research, Jaipur, Rajasthan. All subjects underwent clinical examination, laboratory investigations (including platelet count), abdominal ultrasonography to measure splenic diameter, and upper gastrointestinal endoscopy for detection and grading of esophageal varices. The predictive accuracy of platelet count, splenic diameter, and PC ratio were evaluated using ROC curve analysis.

Results: Of the 156 patients, 84 (53.8%) had esophageal varices, with Grade III varices being the most prevalent (51.2%). Patients with varices had significantly lower platelet counts (131,071.43 vs. 177,625.00/mm³, p=0.000), larger splenic diameters (138.77 vs. 116.40 mm, p=0.000), and lower PC ratios (1011.01 vs. 1591.42, p=0.000) compared to those without varices. ROC curve analysis revealed optimal cutoff values of 126,000/mm³ for platelet count (sensitivity 73.6%, specificity 82.4%), 144.14 mm for splenic diameter (sensitivity 78.2%, specificity 81.9%), and 947.54 for PC ratio (sensitivity 75.7%, specificity 84.7%).

Conclusion: The PC ratio and splenic diameter are reliable non-invasive predictors of esophageal varices in CLD patients. These parameters can help identify high-risk patients who require urgent endoscopic evaluation, potentially reducing the need for unnecessary invasive procedures and improving resource allocation, particularly in settings with limited access to endoscopy.

INTRODUCTION

Chronic liver disease encompasses various conditions affecting hepatic architecture that ultimately result in cirrhotic changes and complications including portal hypertension, esophageal varices, ascites, coagulation disorders, and encephalopathy. Portal hypertension due to chronic liver disease represents the most common cause of esophageal varices globally and is associated with poor outcomes.[1,2] Portal hypertension, first described by Leonardo da Vinci in 1511 and later termed by Augustin Gilbert in 1902, develops from increased splanchnic blood flow and resistance to blood flow through damaged cirrhotic liver architecture. Normal portal venous pressure ranges from 5-10 mm Hg, with portal hypertension defined as a hepatic venous pressure gradient exceeding 6 mm Hg.[3,4] This pressure increase leads to the formation of esophageal varices, which develop in approximately 40% of cirrhotic patients and 60% of those with both cirrhosis and ascites.[5] The rate of development is about 5% annually in cirrhotics without initial varices, with progression to large varices occurring at approximately 10% per year in those with small varices.[6]

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Variceal bleeding significantly increases mortality risk with acute episodes raising death risk by 5-8% after one week and nearly 20% after six weeks.[6] While esophagogastroduodenoscopy (EGD) remains the gold standard for detecting esophageal varices, its invasive nature, cost, and limited availability in resource-constrained settings highlight the need for non-invasive predictive methods.[7,8,9] Various non-invasive parameters have been studied to predict esophageal varices, with consistent findings indicating that splenomegaly and low platelet count are reliable predictors.[1,10,11,12] Thomopoulos et al. (2003) identified thrombocytopenia, splenomegaly, and ascites as independent predictors of large esophageal varices in cirrhotic patients.[13] The platelet count/spleen diameter ratio emerged as a promising marker when Giannini et al. (2003) proposed that a ratio with a cutoff >909 could prevent unnecessary endoscopies without missing esophageal varices diagnoses.[14] This study aims to evaluate the predictive value of platelet count to splenic diameter ratio for esophageal varices in patients with chronic liver disease, potentially establishing a reliable non-invasive tool that could help prioritize high-risk patients for endoscopic evaluation and early intervention.

METHODOLOGY

Study Design and Population

This observational cross-sectional study was conducted over 18 months (May 1, 2023, to October 31, 2024) in the General Medicine and Gastroenterology departments at the National Institute of Medical Sciences & Research, Jaipur, Rajasthan. The study included 156 patients above 18 years of age of both sexes presenting with chronic liver disease. Patients with acute liver disease, previous variceal bleeding, sclerosis or band ligation of esophageal varices, transjugular intrahepatic portosystemic stent shunt (TIPS), surgery for portal hypertension, and pregnant, lactating, or menopausal females were excluded.

Clinical Assessment and Data Collection

After obtaining written informed consent, all patients underwent thorough clinical evaluation including detailed medical history and physical examination. A comprehensive set of laboratory investigations was performed, including complete blood count (with special attention to platelet count), liver function tests, renal function tests, coagulation profile (PT and INR), and viral hepatitis markers (HBsAg and Anti-HCV). All blood samples were processed using standardized laboratory techniques with the Symex XN 1000 autoanalyzer for hematological parameters and the Hitachi 902 automated analyzer for biochemical tests.

Radiological Examination

Abdominal ultrasonography was performed using the Philips Affiniti 30 USG machine with a 3.5 MHz probe. Patients were positioned supine for optimal imaging. Key measurements included liver span (from diaphragmatic surface to visceral edge), liver characteristics (surface texture, internal architecture, edge definition, vascular structure), splenic bipolar length (measured from superior to inferior pole during deep inspiration), presence of ascites, and portal vein diameter (measured at its widest point, just distal to the junction of the splenic vein and superior mesenteric vein). Normal values were defined as splenic length <120 mm and portal vein diameter <13 mm.

Clinical Scoring and Analysis

The platelet count (measured in mm^3) was calculated as a ratio to the spleen's bipolar diameter (in millimeters). The Child-Pugh grading system was applied using laboratory results (bilirubin, albumin, PT/INR) and clinical observations (encephalopathy, ascites). Patients were classified as Grade A (score 5-6), Grade B (score 7-9) or Grade C (score 10-15).

Endoscopic Evaluation

All patients underwent upper gastrointestinal endoscopy after receiving proper counseling and providing written informed consent. Following an 8-hour fast and administration of 10% lidocaine spray for pharyngeal anesthesia, endoscopy was performed with the patient in the left lateral decubitus position using an Olympus CV-190 forward-viewing video endoscope. The entire esophagus was carefully inspected, and any observed esophageal varices were classified according to the Paquet grading system: Grade I (microcapillaries in distal esophagus), Grade II (one or two small varices in distal esophagus), Grade III (medium-sized varices of any number), and Grade IV (large varices in any part of esophagus).

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Statistical Analysis

Categorical variables were reported as numbers and percentages, while quantitative variables were expressed as mean with standard deviation or median with interquartile range. The Chi-square test was used to compare categorical variables between groups with and without varices. A significance level of 5% determined statistical relevance. ROC curve analysis was performed to evaluate the diagnostic accuracy of platelet count, spleen diameter, and PC ratio in predicting esophageal varices. Data analysis was conducted using SPSS version 23.0.

RESULTS

The following section presents the findings from our study of 156 patients with chronic liver disease who were evaluated for the presence of esophageal varices using both invasive endoscopy and non-invasive parameters. The demographic analysis reveals that the majority of patients (35.9%) fell within the 51-60 years age group, followed by the 41-50 years group (29.5%). The male-to-female ratio was 3.3:1, highlighting a strong male predominance in chronic liver disease, though gender distribution did not significantly differ between varices and non-varices groups (p=0.538). Alcohol-related liver disease emerged as the most common etiology (59.0%), with a higher prevalence in the varices group (65.5%) compared to the no-varices group (51.4%). Interestingly, all patients with autoimmune hepatitis (7.7% of total) were in the no-varices group.

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Varices Group (n=84)	No Varices Group (n=72)	Total (n=156)	P-value
Age (years)				
≤40	7 (8.3%)	7 (9.7%)	14 (9.0%)	
41-50	25 (29.8%)	21 (29.2%)	46 (29.5%)	
51-60	30 (35.7%)	26 (36.1%)	56 (35.9%)	0.354
61-70	16 (19.0%)	13 (18.1%)	29 (18.6%)	
>70	6 (7.1%)	5 (6.9%)	11 (7.1%)	
Gender				
Male	63 (75.0%)	57 (79.2%)	120 (76.9%)	0.538
Female	21 (25.0%)	15 (20.8%)	36 (23.1%)	
Etiology				
Alcohol	55 (65.5%)	37 (51.4%)	92 (59.0%)	
NASH	16 (19.0%)	10 (13.9%)	26 (16.7%)	
Hepatitis B	7 (8.3%)	6 (8.3%)	13 (8.3%)	
Cryptogenic	6 (7.1%)	3 (4.2%)	9 (5.8%)	0.002*
AIH	0 (0.0%)	12 (16.7%)	12 (7.7%)	
Hepatitis C	0 (0.0%)	2 (2.8%)	2 (1.3%)	
Wilson's Disease	0 (0.0%)	2 (2.8%)	2 (1.3%)	

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Characteristic	Varices Group (n=84)	No Varices Group (n=72)	Total (n=156)	P-value
Alcohol Intake				
Yes	55 (65.5%)	36 (50.0%)	91 (58.3%)	0.051
No	29 (34.5%)	36 (50.0%)	65 (41.7%)	
CTP Class				
A	14 (16.7%)	24 (33.3%)	38 (24.4%)	
B	45 (53.6%)	39 (54.2%)	84 (53.8%)	0.000*
C	25 (29.8%)	9 (12.5%)	34 (21.8%)	
Encephalopathy				
Present	7 (8.3%)	3 (4.2%)	10 (6.4%)	0.290
Absent	77 (91.7%)	69 (95.8%)	146 (93.6%)	

*Statistically significant (p<0.05); NS = Not significant

This etiology distribution showed a significant association with varices presence (p=0.002). While alcohol intake was more common in the varices group (65.5% vs. 50.0%), this association was marginally above statistical significance (p=0.051). Regarding disease severity, most patients belonged to Child-Pugh class B (53.8%), with class C more prevalent in the varices group (29.8% vs. 12.5%), showing a significant association between advanced liver disease and varices presence (p=0.000). Hepatic encephalopathy was present in only 6.4% of patients, with no significant difference between groups (p=0.290).

Table 2: Distribution of cases according to the Grade of Varices

Grade	Varices	No varices	Total	P value
0	0 (0.0%)	72 (100.0%)	72 (46.2%)	
1	31 (36.9%)	0 (0.0%)	31 (19.9%)	$\chi 2$=156.00
2	10 (11.9%)	0 (0.0%)	10 (6.4%)	P=0.000*
3	43 (51.2%)	0 (0.0%)	43 (27.6%)	
Total	84 (100.0%)	72 (100.0%)	156 (100.0%)	

*Significant (P<0.05)

Among the 156 patients studied, 84 (53.8%) had esophageal varices, while 72 (46.2%) did not. Among those with varices, Grade III (medium-sized) varices were the most prevalent, observed in 43 patients (51.2% of varices group). Grade I varices were found in 31 patients (36.9%), and Grade II varices were seen in only 10 patients (11.9%). The high prevalence of Grade III varices highlights that many patients present with advanced portal hypertension, potentially placing them at increased risk for variceal bleeding. The significant p-value (p=0.000) confirms the distinct classification between the varices and no-varices groups, validating the endoscopic grading system used in this study.

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Table 3: Mean Platelet Count between varices

Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Varices	84	131071.43	100505.204	10966.017	0.000*
No varices	72	177625.00	71203.030	8391.358	

*Significant (P<0.05)

A significant difference in platelet counts was observed between patients with and without varices. The mean platelet count in patients with varices (131,071.43/mm³) was markedly lower than in those without varices (177,625.00/mm³), with a highly significant p-value of 0.000. The greater variability in platelet counts among the varices group (SD: 100,505.20 vs. 71,203.03) suggests more pronounced thrombocytopenia in these patients, likely due to hypersplenism associated with portal hypertension. This finding confirms thrombocytopenia as a key hematological abnormality in patients with advanced liver disease and portal hypertension.

Table 4: Mean Spleen Diameter between varices

Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Varices	84	138.774	20.7668	2.2658	0.000*
No varices	72	116.403	16.2729	1.9178	

*Significant (P<0.05)

Spleen diameter showed a significant difference between the two groups. Patients with varices had a substantially larger mean spleen diameter (138.77 mm) compared to those without varices (116.40 mm), with a p-value of 0.000. The greater standard deviation in the varices group (20.77 vs. 16.27) indicates more variability in splenomegaly among these patients. This finding is consistent with the pathophysiology of portal hypertension, where splenomegaly results from congestion due to increased pressure in the portal venous system, making it a reliable indicator of portal hypertension and associated complications like esophageal varices.

Table 5: Mean Platelet count to Spleen Diameter ratio between varices

Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Varices	84	1011.0087	906.33762	98.88954	0.000*
No varices	72	1591.4239	759.04015	89.45374	

*Significant (P<0.05)

The platelet count to spleen diameter ratio, which combines the effects of thrombocytopenia and splenomegaly, was significantly lower in patients with varices (1011.01) compared to those without varices (1591.42), with a p-value of.0.000. The higher standard deviation in the varices group (906.34 vs. 759.04) reflects greater variability in this parameter. This combined ratio provides a more comprehensive assessment of portal hypertension than either parameter alone, as it accounts for both the mechanical effects of congestion (splenomegaly) and the hematological consequences (thrombocytopenia) of portal hypertension.

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Table 13: Mean Child Turcotte Pugh Score between varices

Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Varices	84	8.202	2.0929	0.2284	0.000*
No varices	72	6.917	1.5360	0.1810	

*Significant (P<0.05)

The Child-Turcotte-Pugh (CTP) score, which assesses the severity of liver disease based on clinical and laboratory parameters, was significantly higher in patients with varices (8.20) compared to those without varices (6.92), with a p-value of 0.000. The greater standard deviation in the varices group (2.09 vs. 1.54) suggests more variability in liver function among these patients. This finding confirms that the presence of varices correlates with more advanced liver disease, as reflected by higher CTP scores. The CTP score thus serves as a valuable indicator not only of overall liver function but also of the risk for complications such as esophageal varices.

Table 17: Correlation of platelet count, spleen length and their ratio with presence of varices

Variables	Mean Values		P value	Logistic Regression Analysis			
	Varices	No varices		Area under the curve	Cut off value	Sensitivity (%)	Specificity (%)
Platelet count (per mm^3)	131071.43	177625.00	0.000	0.748	126000	73.6%	82.4%
Spleen Diameter (in mm)	138.77	116.40	0.000	0.804	144.14	78.2%	81.9%
PC:SD ratio	1011.00	1591.42	0.000	0.787	947.54	75.7%	84.7%

ROC curve analysis was performed to determine the optimal cutoff values and diagnostic accuracy of platelet count, spleen diameter, and PC ratio for predicting esophageal varices. For platelet count, a cutoff value of 126,000/mm^3 provided a sensitivity of 73.6% and specificity of 82.4%, with an area under the curve (AUC) of 0.748. Spleen diameter demonstrated superior diagnostic accuracy with an AUC of 0.804, and a cutoff value of 144.14 mm yielded a sensitivity of 78.2% and specificity of 81.9%. The PC ratio, with a cutoff value of 947.54, showed good diagnostic performance with a sensitivity of 75.7%, specificity of 84.7%, and an AUC of 0.787. Among these parameters, spleen diameter demonstrated the highest overall accuracy (highest AUC), while the PC ratio offered the best specificity, making these parameters valuable non-invasive tools for predicting esophageal varices in patients with chronic liver disease.

DISCUSSION

This study evaluated the predictive value of platelet count to splenic diameter ratio as a non-invasive marker for esophageal varices in patients with chronic liver disease. The results demonstrate that both the PC ratio and individual parameters (platelet count and spleen diameter) are reliable non-invasive predictors of esophageal varices. The demographic analysis revealed a male predominance (male-to-female ratio of 3.3:1) and highest prevalence in the 51-60 years age group (35.9%), followed by the 41-50 years group (29.5%). These findings align with studies by Baig et al.,[15] who reported a median age of 51 years, and Cherian et al.,[16] who found a median age of 42 years. The male predominance observed in our study is consistent with findings from other regions and may be attributed to androgen and androgen receptor signaling, which can accelerate progression to cirrhosis.[17]

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Alcohol-related liver disease emerged as the most common etiology (59.0% of cases), with a higher prevalence in the varices group (65.5%) compared to the no-varices group (51.4%). This finding is consistent with other studies, including Kumar et al.[18], who reported alcohol as the cause in 52% of patients, and Cherian et al.[16], who found 42.4% of cases to be alcohol-related. The significant association between etiology and varices presence (p=0.002) highlights the importance of etiology-specific approaches in predicting and managing complications of chronic liver disease.

Our study found significantly lower platelet counts in patients with varices compared to those without (mean 131,071.43 vs. 177,625.00/mm³, p=0.000). A cutoff value of 126,000/mm³ yielded a sensitivity of 73.6% and specificity of 82.4% for predicting varices. This finding is consistent with numerous studies that have identified thrombocytopenia as a predictor of esophageal varices. For example, Grace et al.[19] found that 94.5% of patients with esophageal varices also had thrombocytopenia, and Chalasani et al.[20] identified a platelet count below 88,000 as a significant risk factor for large varices.

Spleen bipolar length/diameter (SD) was significantly larger in patients with varices compared to those without (mean 138.77 vs. 116.40 mm, p=0.000). The cutoff value of 144.14 mm demonstrated high predictive accuracy, with a sensitivity of 78.2% and specificity of 81.9%. Sarangapani et al.[12] reported similar findings, with a spleen bipolar length exceeding 138 mm indicative of varices. These results align with Chalasani et al.'s observations, emphasizing the predictive value of spleen bipolar length in identifying varices.[20]

The PC ratio, also known as the Giannini index, showed significant differences between patients with and without varices (mean 1011.01 vs. 1591.42, p=0.000). The cutoff value of 947.54 provided a sensitivity of 75.7% and specificity of 84.7% for predicting varices. These findings differ somewhat from Giannini et al.'s original proposal of a cutoff value of 909[14], which has been the reference in many subsequent studies. The variation in optimal cutoff values across studies may be attributed to differences in study populations, disease etiologies and severity.

The performance of the PC ratio in various studies shows considerable variation. Sethar et al.[21] found a cutoff value of 1445 in hepatitis-related cirrhosis, while Agha et al.[22] reported a cutoff of 885 in schistosoma-related chronic liver disease. In our study, which predominantly included alcohol-related cirrhosis, the cutoff value was 947.54. These differences underscore the need to establish population-specific cutoff values for optimal diagnostic accuracy.

The Child-Turcotte-Pugh (CTP) score was significantly higher in patients with varices, indicating more advanced liver disease in this group. A CTP score greater than 6/15 was significantly associated with the presence of varices (p=0.000). These findings are consistent with Cherian et al.'s study, which reported a significant association for CTP Classes B and C with varices (p=0.001, odds ratio 3.3).[16] This highlights the importance of comprehensive liver function assessment in predicting the risk of complications like esophageal varices.

Our study has several limitations, including its single-center design, cross-sectional nature, and lack of assessment of the predictive value of these parameters for variceal bleeding. However, it also has notable strengths, including a relatively large sample size with diverse etiologies of chronic liver disease, comprehensive evaluation of multiple non-invasive parameters, and the use of endoscopy as the gold standard for varices detection.

CONCLUSION

This study establishes the platelet count to splenic diameter ratio and splenic diameter as effective, non-invasive markers for predicting the presence of esophageal varices in patients with chronic liver disease. The optimal cutoff values identified in this study (947.54 for PC ratio and 144.14 mm for splenic diameter) demonstrate good sensitivity and specificity for predicting varices. These non-invasive parameters offer significant advantages, particularly in resource-limited settings where access to endoscopy may be restricted. By incorporating these markers into routine clinical evaluations, healthcare providers can prioritize high-risk patients for endoscopic screening and implement early interventions to prevent complications such as variceal bleeding. The study also highlights the importance of considering disease etiology and severity in the assessment of varices risk. Alcohol-related liver disease emerged as the most common etiology associated with varices, emphasizing the need for targeted interventions to address alcohol use disorders in liver disease

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management. Future research should focus on validating these findings in multicenter studies with diverse populations, evaluating the predictive value of these parameters for variceal bleeding, and assessing their utility in monitoring disease progression and response to treatment.

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