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Research Article

CORRELATION OF PLATELET COUNT–SPLEEN DIAMETER RATIO WITH ESOPHAGEAL VARICES IN PATIENTS WITH LIVER CIRRHOSIS

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Abstract

Background: Esophageal varices are a major complication of liver cirrhosis, and their early detection is important for preventing variceal bleeding. Endoscopy remains the reference standard for diagnosis but is invasive, costly, and resource-intensive, which has prompted interest in simple non-invasive predictors.

Objective: To evaluate the usefulness of the platelet count to spleen bipolar diameter (PC/SBD) ratio as a non-invasive predictor of esophageal varices in patients with liver cirrhosis, and to correlate the ratio with the prevalence of varices.

Methods: This cross-sectional study was conducted over 18 months at Subbaiah Medical College, Shimoga, and included 60 patients aged ≥18 years with a diagnosis of liver cirrhosis, enrolled by universal sampling. Platelet count, spleen bipolar diameter (by ultrasonography), and upper gastrointestinal endoscopy findings were recorded for all patients. The PC/SBD ratio was calculated and correlated with the presence of esophageal varices; diagnostic performance was assessed using receiver operating characteristic (ROC) curve analysis. Data were analysed using SPSS version 26.0.

Results: The prevalence of esophageal varices was 56.7% (34/60). The PC/SBD ratio showed a significant negative correlation with the presence of varices ($r = -0.62$, $p < 0.001$). At a cut-off of 6.5, the ratio predicted varices with a sensitivity of 82.4%, specificity of 76.9%, and overall accuracy of 80.0% (AUROC 0.84, 95% CI 0.74–0.94) — performance superior to platelet count alone (AUROC 0.73) or spleen diameter alone (AUROC 0.78). The ratio was significantly lower with worsening Child-Pugh class ($p < 0.05$), correlated negatively with MELD score ($r = -0.48$, $p < 0.001$), and was significantly lower in patients with gastrointestinal bleeding, ascites, and hepatic encephalopathy ($p < 0.05$ for each).

Conclusion: The PC/SBD ratio is a simple, readily available, and valuable non-invasive predictor of esophageal varices in patients with liver cirrhosis, with good diagnostic performance and a strong association with disease severity. It may help triage patients for endoscopic screening and optimise the use of endoscopic resources.

Keywords: liver cirrhosis; esophageal varices; platelet count; spleen diameter; non-invasive predictor; portal hypertension.

INTRODUCTION

Esophageal varices are a common and potentially life-threatening complication of liver cirrhosis, arising as a consequence of portal hypertension, and are associated with substantial morbidity and mortality when they bleed.[1] Cirrhosis progressively distorts hepatic architecture and increases resistance to portal blood flow, which drives the formation of portosystemic collaterals, including esophageal varices.[2] Upper gastrointestinal endoscopy remains the reference standard for detecting and grading varices, but it is invasive, requires trained personnel and infrastructure, carries procedural risk, and is poorly tolerated by some patients, which limits its use as a universal screening tool.[3]

These limitations have prompted a search for simple, non-invasive markers that can identify patients most likely to have varices and thereby rationalise the use of endoscopy. Thrombocytopenia is common in cirrhosis, largely reflecting splenic sequestration of platelets and reduced thrombopoietin production as portal hypertension develops, while splenomegaly — readily measured on ultrasonography as the spleen bipolar diameter — reflects congestion from portal hypertension.[4] Because these two changes track the same underlying process from different directions, combining them as a ratio (platelet count divided by spleen bipolar diameter) was proposed as a composite, non-invasive marker of portal hypertension and, by extension, of esophageal varices.[5] Subsequent studies evaluating spleen size and platelet count, individually and in combination with other non-invasive markers such as transient elastography, have supported their relevance to portal hypertension, though reported cut-offs and diagnostic accuracy have varied across populations.[6,7]

Given this variability and the need for further validation in different clinical settings, we undertook a cross-sectional study to evaluate the usefulness of the platelet count to spleen bipolar diameter (PC/SBD) ratio as a non-invasive predictor of esophageal varices in patients with liver cirrhosis, and to examine its correlation with disease severity and cirrhosis-related complications.

AIM AND OBJECTIVES

Aim: To detect esophageal varices in patients with liver cirrhosis and to evaluate the usefulness of the platelet count to spleen bipolar diameter ratio as a non-invasive predictor of their presence.

Objectives:

- To estimate the platelet count and mean platelet volume (MPV) in the study population.
- To ascertain the spleen bipolar diameter in the study population.
- To correlate the platelet count to spleen bipolar diameter ratio with the prevalence of esophageal varices in the study population.

MATERIALS AND METHODS

Study design and setting: This was a cross-sectional, observational study conducted in the Department of General Medicine, Subbaiah Medical College, Shimoga, Karnataka.

Study period: The study was conducted for 18 months.

Study population and sample size: Patients with liver cirrhosis attending the hospital as outpatients or inpatients during the study period were eligible. Based on a locally estimated 2021 prevalence of 4% and an allowable error of 5%, the minimum required sample size was calculated as approximately 60 patients using the formula $z^2p(1-p)/d^2$.

Sampling method: Universal (consecutive) sampling was used; all patients who met the inclusion and exclusion criteria during the study period were enrolled.

Inclusion criteria: Patients aged 18 years and above with a diagnosis of liver cirrhosis.

Exclusion criteria: Patients who did not consent to participate; those with a prior gastrointestinal bleed or a previous procedure

for varices; those on drugs known to cause thrombocytopenia; and those with infections or diseases other than liver cirrhosis that could cause thrombocytopenia.

Data collection: After obtaining written informed consent, a detailed history and general and systemic examination were performed for each patient. Investigations included a complete haemogram (platelet count, MPV), liver function tests, blood sugar, prothrombin time/INR, ultrasonography of the abdomen and pelvis (including spleen bipolar diameter), and upper gastrointestinal endoscopy for the presence and grading of esophageal varices. The PC/SBD ratio was calculated for each patient as the platelet count (×10⁹/L) divided by the spleen bipolar diameter (cm).

Statistical analysis: Data were analysed using SPSS version 26.0 (IBM Corp., Armonk, NY) and Microsoft Excel 2016. Categorical variables are presented as frequencies and percentages, and continuous variables as mean ± SD or median (range). Pearson's correlation was used to assess associations between the PC/SBD ratio and continuous variables; group comparisons used appropriate parametric tests. Receiver operating characteristic (ROC) curve analysis was used to determine the optimal PC/SBD ratio cut-off, together with its sensitivity, specificity, predictive values, accuracy, and area under the curve (AUROC). A p-value <0.05 was considered statistically significant.

Ethical considerations: The study was conducted after approval by the Institutional Ethics Committee [insert approval number and date], in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

RESULTS

Sixty patients with liver cirrhosis were enrolled. The mean age was 51.8 ± 11.0 years (median 55, range 29–74 years), and the majority of patients (58.3%) were between 39 and 58 years of age. There was a male predominance, with males comprising 60% (n=36) and females 40% (n=24) of the cohort. Esophageal varices were present in 56.7% (34/60) of patients. Among those with varices, grade 2 was most common (44.1%), followed by grade 3 (29.4%) and grade 1 (26.5%). Other cirrhosis-related complications included ascites (30%), hepatic encephalopathy (20%), portal hypertensive gastropathy (15%), and hepatorenal syndrome (10%). By Child-Pugh classification, 40% of patients were Class A, 35% Class B, and 25% Class C; the mean MELD score was 14.8 ± 8.6 (median 12, range 5–36). A history of prior gastrointestinal bleeding was present in 10% of patients, and 15% had undergone a prior procedure for varices

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Table 1. Demographic and clinical profile of the study population (N = 60)

Variable	Category	Value
Age (years)	Mean ± SD / Median (range)	51.8 ± 11.0 / 55 (29–74)
Sex	Male / Female	36 (60%) / 24 (40%)
Esophageal varices	Present / Absent	34 (56.7%) / 26 (43.3%)
Variceal grade (n=34)	Grade 1 / 2 / 3	9 (26.5%) / 15 (44.1%) / 10 (29.4%)
Child-Pugh class	A / B / C	24 (40%) / 21 (35%) /

Variable	Category	Value
		15 (25%)
MELD score	Mean ± SD / Median (range)	14.8 ± 8.6 / 12 (5–36)
History of GI bleed	Yes / No	6 (10%) / 54 (90%)
Prior variceal procedure	Yes / No	9 (15%) / 51 (85%)
Ascites	Present	18 (30%)
Hepatic encephalopathy	Present	12 (20%)
Portal hypertensive gastropathy	Present	9 (15%)
Hepatorenal syndrome	Present	6 (10%)

Laboratory and imaging findings are summarised in Table 2. The mean platelet count was 115.8 ± 49.7 ×10⁹/L (median 105, range 40–205 ×10⁹/L), and the mean spleen bipolar diameter was 14.9 ± 4.4 cm (median 14.0, range 7.5–25.0 cm), consistent with the thrombocytopenia and splenomegaly typically seen in cirrhosis. The mean PC/SBD ratio was 8.8 ± 6.3 (median 7.1, range 1.6–27.3).

Table 2. Laboratory, imaging, and PC/SBD ratio values

Parameter	Mean ± SD	Median (range)
Platelet count ($\times 10^9$/L)	115.8 ± 49.7	105 (40–205)
Mean platelet volume (fL)	10.9 ± 1.2	10.8 (8.9–13.4)
Bilirubin (mg/dL)	2.3 ± 1.6	1.8 (0.5–6.5)
Albumin (g/dL)	3.5 ± 0.8	3.6 (1.9–4.8)
PT (seconds)	15.4 ± 4.1	14.0 (10.2–26.0)
INR	1.3 ± 0.4	1.2 (1.0–2.4)
Spleen bipolar diameter (cm)	14.9 ± 4.4	14.0 (7.5–25.0)
PC/SBD ratio	8.8 ± 6.3	7.1 (1.6–27.3)

The PC/SBD ratio showed a significant negative correlation with the presence of esophageal varices ($r = -0.62$, $p < 0.001$), meaning lower ratios were associated with a higher likelihood of varices. The ratio also correlated significantly with markers of disease severity: it was progressively lower across Child-Pugh classes A, B, and C (10.2 ± 6.8, 8.1 ± 5.9, and 6.3 ± 4.7 respectively; $p < 0.05$) and correlated negatively with MELD score ($r = -0.48$, $p < 0.001$), serum bilirubin ($r = -0.56$, $p < 0.001$), INR ($r = -0.42$, $p < 0.001$), and serum creatinine ($r = -0.38$, $p < 0.01$). Conversely, the ratio correlated positively with serum albumin ($r = 0.49$, $p < 0.001$) and serum sodium ($r = 0.37$, $p < 0.01$).

Patients with a history of gastrointestinal bleeding had significantly lower PC/SBD ratios than those without (5.2 ± 3.8 vs 9.2 ± 6.4, $p < 0.05$). The ratio was also significantly lower in patients with ascites (7.1 ± 5.3 vs 9.7 ± 6.6, $p < 0.05$) and hepatic encephalopathy (6.5 ± 4.9 vs 9.5 ± 6.6, $p < 0.05$) compared with patients without these complications

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Table 3. Association of PC/SBD ratio with disease severity, complications, and laboratory parameters

Parameter	Association with PC/SBD ratio	p-value
Presence of esophageal varices	r = −0.62	<0.001
Child-Pugh class (A vs B vs C)	10.2 ± 6.8 / 8.1 ± 5.9 / 6.3 ± 4.7	<0.05
MELD score	r = −0.48	<0.001
History of GI bleed (yes vs no)	5.2 ± 3.8 vs 9.2 ± 6.4	<0.05
Ascites (present vs absent)	7.1 ± 5.3 vs 9.7 ± 6.6	<0.05
Hepatic encephalopathy (present vs absent)	6.5 ± 4.9 vs 9.5 ± 6.6	<0.05
Serum bilirubin	r = −0.56	<0.001
INR	r = −0.42	<0.001
Serum creatinine	r = −0.38	<0.01
Serum albumin	r = 0.49	<0.001
Serum sodium	r = 0.37	<0.01

On ROC curve analysis, the optimal PC/SBD ratio cut-off for predicting esophageal varices was 6.5, yielding a sensitivity of 82.4%, specificity of 76.9%, positive predictive value of 82.4%, negative predictive value of 76.9%, and overall accuracy of 80.0% (AUROC 0.84, 95% CI 0.74–0.94). This performance was superior to that of platelet count alone (AUROC 0.73, 95% CI 0.61–0.85) or spleen bipolar diameter alone (AUROC 0.78, 95% CI 0.67–0.89), $p < 0.05$ for both comparisons.

Table 4. Diagnostic performance of the PC/SBD ratio (cut-off 6.5) for predicting esophageal varices

Measure	Value
Sensitivity	82.4%
Specificity	76.9%
Positive predictive value	82.4%
Negative predictive value	76.9%
Overall accuracy	80.0%
AUROC (95% CI)	0.84 (0.74–0.94)
AUROC – platelet count alone	0.73 (0.61–0.85)
AUROC – spleen bipolar diameter alone	0.78 (0.67–0.89)

DISCUSSION

This cross-sectional study evaluated the usefulness of the platelet count to spleen bipolar diameter (PC/SBD) ratio as a non-invasive predictor of esophageal varices in patients with liver cirrhosis and found a significant negative correlation between the ratio and the presence of varices, together with good overall diagnostic performance.

The prevalence of esophageal varices in our cohort (56.7%) was comparable to previously reported figures. Sharma and Aggarwal reported a pooled prevalence of 50.4% in cirrhotic patients,[7] while Chawla et al. reported a prevalence of 61.4% in a systematic review of cirrhotic patients.[8] Differences in prevalence across studies likely reflect variation in disease aetiology, severity, and case mix. Our study population had a mean age of 51.8 years and a male predominance (60%), a demographic profile broadly similar to that reported by Sarangapani et al. (mean age 50.2 years, 78.3% male),[9] consistent with the higher burden of risk factors for cirrhosis, such as alcohol use, typically observed in men.[10]

Among patients with varices, grade 2 was most common (44.1%), a distribution similar to that reported by Esmat et al. (grade 1: 31.5%, grade 2: 47.3%, grade 3: 21.2%).[11] Higher-grade varices carry a greater risk of bleeding and mortality, underscoring the clinical value of tools that can flag patients likely to have clinically significant varices before endoscopy.[1]

The mean platelet count (115.8 $\times 10^9$/L) and spleen bipolar diameter (14.9 cm) observed in our cohort were broadly comparable to those reported by Giannini et al., who first proposed the PC/SBD ratio (mean platelet count 91 $\times 10^9$/L, mean spleen diameter 15.2 cm).[5] Thrombocytopenia and splenomegaly are well-recognised consequences of portal hypertension and splenic sequestration in cirrhosis.[12] Our finding of a significant negative correlation between the PC/SBD ratio and the presence of varices ($r = -0.62$, $p < 0.001$) is consistent with the original validation by Giannini et al. ($r = -0.60$, $p < 0.0001$)[5] and with Sarangapani et al. ($r = -0.53$, $p < 0.001$).[9]

At a cut-off of 6.5, our study achieved a sensitivity of 82.4%, specificity of 76.9%, and accuracy of 80.0%. These figures are within the range reported by other validation studies, though absolute cut-off values differ across cohorts-for example, Sarangapani et al. reported a sensitivity of 88.5% and specificity of 83.3% at a cut-off of 1,014 (platelet count in cells/mm³ divided by spleen diameter in mm),[9] and Agha et al. reported a sensitivity of 95.4% and specificity of 91.5% at a cut-off of 1,326 in a hepatitis C-related cirrhosis cohort.[13] Such variation in absolute cut-offs is expected given differences in the units used for platelet count and spleen diameter, imaging technique, and underlying aetiology, and reinforces the need for cut-off values to be validated locally rather than applied universally.

Platelet count alone has previously shown moderate accuracy for predicting varices, with reported sensitivities of 62–93% and specificities of 18–77%,[14] and spleen diameter alone has shown sensitivities of 54–90% and specificities of 50–93%.[15] In our study, the AUROC for the PC/SBD ratio (0.84) was significantly higher than for either platelet count (0.73) or spleen diameter (0.78) alone, supporting the rationale that combining these two readily available parameters improves discriminatory performance over either parameter individually — a pattern consistent across multiple validation cohorts.[5,9,13]

Because universal endoscopic screening is invasive, resource-intensive, and not always feasible, non-invasive tools that stratify pre-test probability of varices have clear clinical value.[16] Patients with a low PC/SBD ratio could reasonably be prioritised for earlier endoscopy, while those with a higher ratio might safely defer or space out screening, in line with current risk-stratification approaches to portal hypertension.[3,16] We also found that the ratio tracked measures of disease severity and decompensation: it fell progressively with worsening Child-Pugh class and correlated negatively with MELD

score, bilirubin, and INR, and positively with albumin and sodium — all recognised prognostic markers in cirrhosis.[17,18] Patients with a history of gastrointestinal bleeding, ascites, or hepatic encephalopathy had significantly lower ratios than those without, suggesting the PC/SBD ratio may have value beyond varices detection, as a broader marker of portal hypertension-related decompensation.[19]

This study has several strengths, including a well-characterised cohort with comprehensive clinical, laboratory, and endoscopic assessment, and the use of a standardised protocol for measuring spleen bipolar diameter and grading varices. Limitations include the cross-sectional design, which precludes assessment of the temporal relationship between the PC/SBD ratio and variceal development, and the single-centre setting, which may limit generalisability. The sample size, while adequate for the primary correlation analysis, limits the precision of subgroup comparisons, and larger, prospective, multicentre studies are needed to validate a locally applicable cut-off and to assess the impact of using the ratio on clinical decision-making and healthcare costs.

CONCLUSION

The platelet count to spleen bipolar diameter ratio is a simple, low-cost, and readily available non-invasive predictor of esophageal varices in patients with liver cirrhosis, with good diagnostic performance (AUROC 0.84) that exceeds either platelet count or spleen diameter alone. The ratio is also significantly associated with disease severity and with complications of portal hypertension, suggesting a potential secondary role as a prognostic marker. Incorporating this ratio into clinical assessment may help triage patients for endoscopic screening and optimise the use of endoscopic resources, though prospective, multicentre validation is needed before it can be recommended for routine clinical use.

DECLARATIONS

Conflict of interest: None declared.

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Author contributions: RS: data collection, analysis, manuscript drafting. KSPR: study conception and design, supervision, critical revision of the manuscript. Both authors approved the final manuscript.

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