

A COMPARATIVE STUDY OF HEMATOLOGICAL AND RADIOLOGICAL PARAMETERS IN CIRRHOTIC PATIENTS WITH OR WITHOUT OESOPHAGEAL VARICES

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ABSTRACT

Background: Oesophageal varices are a major complication of portal hypertension in cirrhotic patients and may result in life-threatening upper gastrointestinal bleeding. Although upper gastrointestinal endoscopy remains the gold standard for diagnosis and grading, its invasive nature and limited accessibility have increased interest in simple, non-invasive predictors. This study evaluated the association of selected hematological and radiological parameters with oesophageal varices and acute variceal bleeding in cirrhotic patients.

Methods: A cross-sectional, comparative observational study was conducted in the Department of General Medicine at Dr. D.Y. Patil Medical College, Hospital and Research Institute, Kolhapur, after institutional ethical approval. A total of 98 adults with cirrhosis were included, comprising 49 patients with oesophageal varices and 49 cirrhotic patients without varices. All participants underwent clinical assessment, complete blood investigations, liver function tests, abdominal ultrasonography, and upper gastrointestinal endoscopy. Hematological parameters included platelet count, serum albumin, total bilirubin, and hemoglobin. Radiological assessment included portal vein and spleen diameter, and the platelet-to-spleen diameter ratio was calculated.

Results: Patients with oesophageal varices had significantly lower platelet counts than those without varices ($64,544 \pm 13,880$ vs. $191,817 \pm 31,512/\mu\text{L}$; $p < 0.0001$), lower serum albumin (2.50 ± 0.27 vs. 4.00 ± 0.33 g/dL; $p < 0.0001$), lower hemoglobin (9.52 ± 1.08 vs. 12.04 ± 0.91 g/dL; $p < 0.0001$), and higher total bilirubin (4.80 ± 1.06 vs. 1.66 ± 0.74 mg/dL; $p < 0.0001$). Portal vein diameter was significantly greater in patients with varices (15.14 ± 1.44 vs. 11.01 ± 0.58 mm; $p < 0.0001$) and increased progressively with variceal grade (Grade I: 14.43 ± 0.90 mm; Grade II: 15.10 ± 1.61 mm; Grade III: 16.01 ± 1.28 mm; $p = 0.0204$). Spleen diameter was also significantly greater in patients with varices (16.51 ± 1.69 vs. 11.58 ± 0.80 cm; $p < 0.0001$). The platelet-to-spleen diameter ratio was markedly lower in patients with varices (394.17 ± 91.64 vs. 1663.57 ± 292.26 ; $p < 0.0001$). Acute variceal bleeding occurred in 12 patients (12.2%) and was associated with significantly lower platelet count, serum albumin, and hemoglobin, larger portal vein and spleen diameters, and a lower platelet-to-spleen diameter ratio.

Conclusion: Platelet count, serum albumin, total bilirubin, hemoglobin, portal vein diameter, spleen diameter, and platelet-to-spleen diameter ratio were significantly associated with oesophageal varices and acute variceal bleeding in cirrhotic patients. These readily available and non-invasive parameters may assist in identifying high-risk patients and prioritizing endoscopic evaluation, particularly in resource-limited settings. Upper gastrointestinal endoscopy remains essential for definitive diagnosis and grading.

KEY WORDS: Cirrhosis; Oesophageal varices; Portal hypertension; Platelet count; Serum albumin; Total bilirubin; Portal vein diameter; Splenomegaly; Platelet-to-spleen diameter ratio; Variceal bleeding.

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INTRODUCTION

Cirrhosis of the liver represents the final common pathway of various chronic liver diseases, characterized by progressive hepatic fibrosis, architectural distortion, and portal hypertension. One of the most serious complications of portal hypertension is the development of oesophageal varices, which occur due to diversion of portal blood flow through the oesophageal venous

plexus. Once formed, varices carry a substantial risk of rupture and upper gastrointestinal bleeding, associated with considerable morbidity and mortality. [1] Timely identification of oesophageal varices is therefore essential, as early recognition permits preventive interventions such as non-selective beta-blockers and endoscopic variceal ligation, thereby reducing the risk of

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variceal hemorrhage. Upper gastrointestinal endoscopy remains the gold standard for diagnosis and grading; however, it is invasive, relatively costly, requires specialized expertise, and may be unsuitable for repeated surveillance. These limitations have led to increasing interest in reliable non-invasive predictors that can identify cirrhotic patients at increased risk of varices and prioritize those requiring endoscopic evaluation. [2]

Hematological and radiological parameters are important non-invasive indicators of portal hypertension and variceal development. Progressive hepatic fibrosis increases intrahepatic vascular resistance and portal pressure, resulting in splenic congestion and hypersplenism. Thrombocytopenia is consequently one of the most consistently studied hematological markers of portal hypertension and oesophageal varices. Anemia and other hematological abnormalities may additionally reflect advanced liver disease, hypersplenism, or bleeding. Radiological assessment, particularly ultrasonography with Doppler, provides complementary structural and hemodynamic information. Increased portal vein diameter, splenomegaly, and portosystemic collateral formation are commonly associated with portal hypertension and oesophageal varices. Computed tomography and magnetic resonance imaging can further demonstrate liver morphology, collateral circulation, and splenic changes. [3,4]

Combining hematological and radiological parameters provides a more comprehensive assessment of the pathophysiological changes underlying variceal formation. Platelet count and platelet-to-spleen diameter ratio reflect the combined effects of hypersplenism and portal hypertension, while indices such as the AST-to-platelet ratio index (APRI) and Fibrosis-4 (FIB-4) provide information regarding hepatic fibrosis. Similarly, splenic size and portal vein diameter provide readily measurable radiological indicators of portal hypertensive burden. Studies have demonstrated that combining these routinely available parameters can improve prediction of oesophageal varices and help reduce unnecessary endoscopic procedures in low-risk patients while identifying those who would benefit from timely endoscopic assessment. [5]

The clinical detection of oesophageal varices remains challenging because many cirrhotic patients remain asymptomatic until variceal hemorrhage occurs. Unlike clinically evident complications such as ascites or hepatic encephalopathy, varices may develop silently, making effective screening particularly important. This issue is especially relevant in resource-limited settings where endoscopy may not be immediately available or accessible. Routine hematological investigations and abdominal ultrasonography are inexpensive, widely available, non-invasive, and easily repeatable, making them attractive tools for initial risk stratification and surveillance. [6]

The hematological abnormalities associated with cirrhosis result from multiple mechanisms, including splenic sequestration, bone marrow suppression, and reduced thrombopoietin production due to impaired hepatic function. Among these, thrombocytopenia has demonstrated the most consistent association with the presence and severity of oesophageal varices. The platelet count-to-spleen size ratio has also been investigated as a useful composite marker capable of distinguishing patients with and without clinically significant varices. Radiological findings such as splenomegaly and increased portal vein diameter reflect the underlying portal hypertension responsible for variceal formation. Doppler assessment of portal venous flow and velocity may provide additional information, while liver and spleen stiffness measurements obtained using advanced imaging techniques are emerging as promising non-invasive predictors. [7]

Despite considerable research, no single hematological or radiological parameter has demonstrated universally consistent diagnostic performance. Differences in patient populations, disease etiology, methodology, and proposed cut-off values have limited the widespread application of individual markers. Consequently, combinations of parameters and predictive scores may provide greater clinical utility. The Baveno VI consensus incorporated non-invasive parameters such as liver stiffness and platelet count to identify patients at low risk of high-risk varices who may safely avoid endoscopy. Continued refinement of these approaches aims to achieve an appropriate balance between sensitivity and specificity while maintaining patient safety and optimizing healthcare resources.

Understanding the relationship between routine hematological and radiological parameters and oesophageal varices provides important clinical and pathophysiological information. The development of varices varies among cirrhotic patients according to factors such as severity of fibrosis, etiology of liver disease, and portal pressure. Correlating readily available laboratory and imaging findings with the presence and severity of varices may therefore facilitate improved risk stratification, monitoring, and individualized management. [8,9]

Oesophageal varices remain one of the most serious complications of cirrhosis and continue to represent a major global health concern. Although upper gastrointestinal endoscopy remains the definitive diagnostic modality, its invasive nature and limited accessibility have stimulated the search for effective non-invasive alternatives. Hematological parameters, particularly platelet count and platelet-to-spleen ratio, together with radiological indicators such as splenic size and portal vein diameter, may provide valuable information regarding variceal risk. Their low cost, accessibility, and non-invasive nature make them particularly relevant for screening and risk stratification,

especially in resource-constrained settings. Further validation and integration of these parameters into predictive algorithms may reduce unnecessary endoscopies while facilitating timely preventive management of high-risk cirrhotic patients. [10]

METHODOLOGY

A cross-sectional, comparative, and observational study was carried out after receiving official clearance from the IRC and IEC of Dr. D.Y. Patil Medical College, Hospital, and Research Institute, Kolhapur. The study was conducted at Inpatient department (IPD) of the General Medicine Department at Dr. D.Y. Patil Medical College, Hospital, and Research Institute, Kolhapur. On patients attending the OPD for routine follow-up of cirrhosis and those admitted to the IPD for complications related to liver disease were screened for eligibility. All participants were selected according to the inclusion and exclusion criteria. The minimum sample size was 49. (Study group – 49, Comparative group – 49).

Inclusion criteria

Study Group

Adults aged 18 years or older and all genders, participants through a confirmed diagnosis of cirrhosis based on medical, workshop, imaging criteria, participants identified with oesophageal varices in upper GI endoscopy, patients with acute variceal bleed, patients giving valid consent.

Comparative Group

Participants through cirrhosis who experienced upper GI endoscopy but through no oesophageal varices.

Exclusion Criteria

Age less than 18 years old, patients who have undergone previous variceal treatment procedures such as band ligation or sclerotherapy, patients with significant co

morbid conditions that altering the liver function like heart failure, inability to Provide Informed Consent.

Study Procedure

After procurement consent, eligible participants were exposed to comprehensive clinical examination and investigations. Cirrhosis was confirmed based on a amalgamation of medical aspects, liver function tests, and ultrasonographic evidence of a cirrhotic liver. All participants experienced diagnostic upper GI endoscopy as part of their routine clinical evaluation. The endoscopic findings were recorded, and patients were categorized into study and comparative groups accordingly. Subsequently, hematological investigations including platelet count and serum albumin levels were obtained from the hospital's central laboratory using standard techniques. Radiological evaluation included ultrasonography of the abdomen and pelvis, with particular emphasis on spleen size as well as portal vein diameter. These measurements were carried out by experienced radiologists using standardized protocols to minimize inter-observer variability. For each patient, the platelet count-to-spleen diameter ratio was considered as an additional derived marker. All data were entered into a structured master chart for further analysis.

RESULT

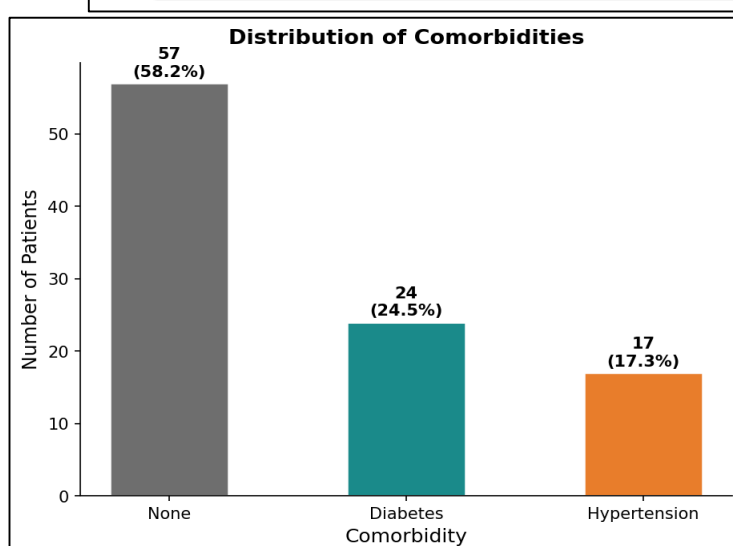
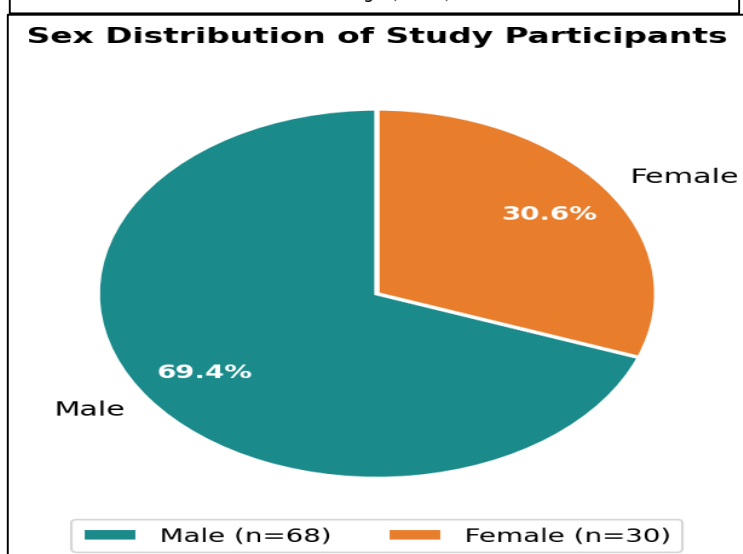
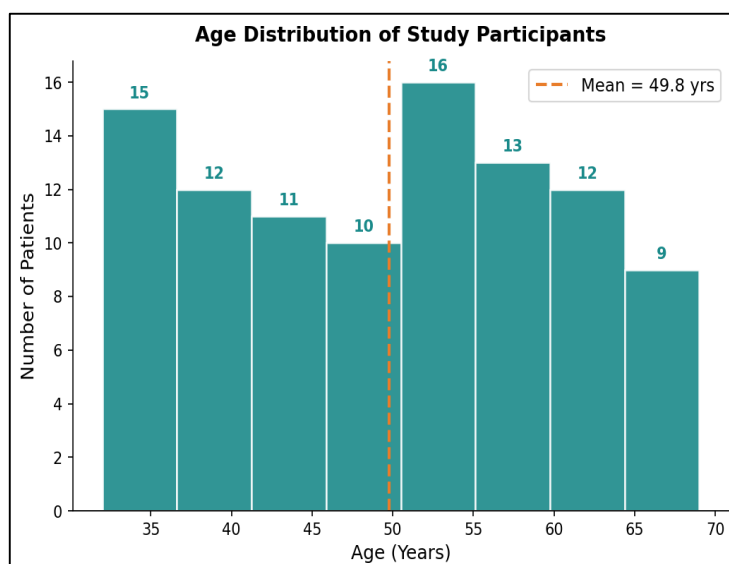
Demographic Profile of Study Participants

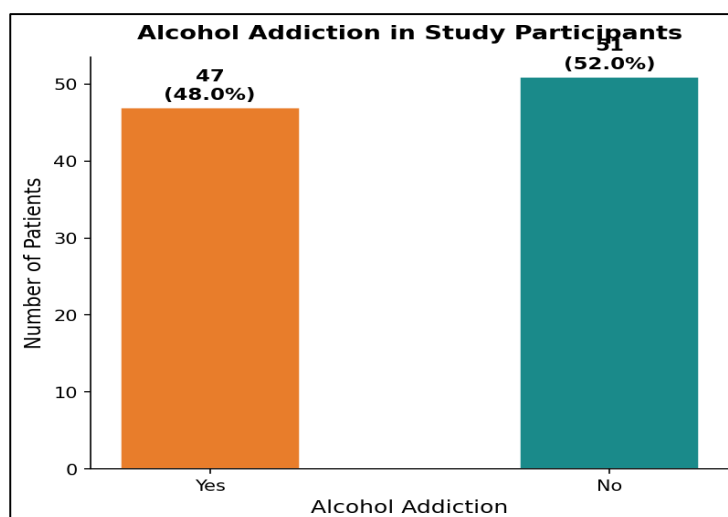
The study included 98 cirrhotic patients with a mean age of 49.77 ± 10.92 years, median age 51 years, and age range 32–69 years. Males were predominant, comprising 68 patients (69.4%), while females were 30 (30.6%). Comorbidities included diabetes mellitus in 24

(24.5%) and hypertension in 17 (17.3%). Alcohol addiction was present in 47 patients (48.0%), and all patients had liver disease.

Table 1: Demographic Profile of Study Participants (N = 98)

Variable	Category	Number (n)	Percentage (%)
Total Participants	—	98	100.0
Age (Years)	Mean $\pm$ SD	49.77 ± 10.92	—
	Range	32 – 69	—
	Median	51.0	—
Sex	Male	68	69.4
	Female	30	30.6
	None	57	58.2
Comorbidities	Diabetes Mellitus	24	24.5
	Hypertension	17	17.3
	Alcohol Addiction	47	48.0
Alcohol Addiction	No	51	52.0
	Yes	98	100.0
History of Liver Disease	Yes	98	100.0





Graph 1: Demographic Profile of Study Participants (N = 98)

ENDOSCOPIC FINDINGS

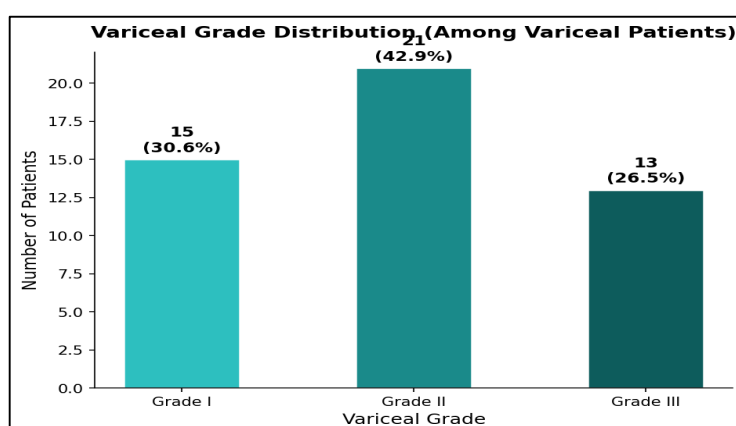
Distribution of Oesophageal Varices and Variceal Grade

Oesophageal varices were present in 49 patients (50.0%) and absent in 49 patients (50.0%). Among patients with varices, Grade II was most common, seen in 21 patients (42.9%), followed by Grade I in 15 (30.6%) and Grade III in 13 (26.5%). Acute variceal bleed was present in 12 patients (12.2%) and absent in 86 (87.8%).

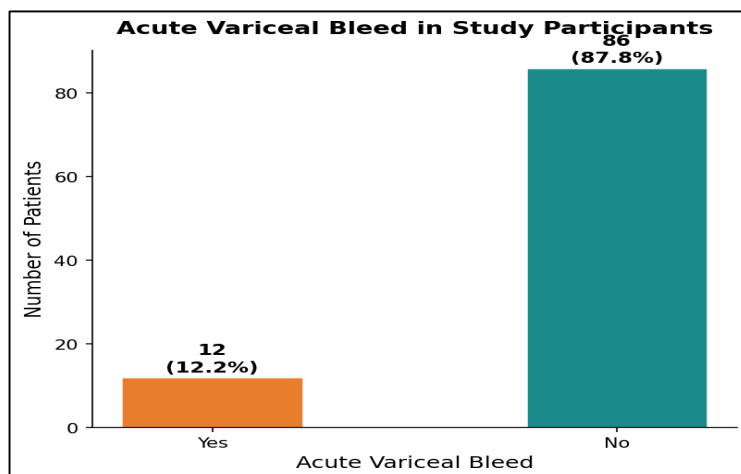
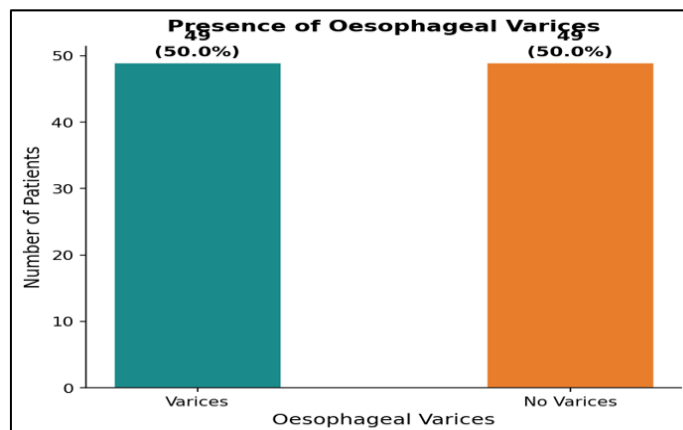
Table 2: Distribution of Oesophageal Varices and Variceal Grade (N = 98)

Variable	Category	Number (n)	Percentage (%)
Oesophageal Varices	Present	49	50.0
	Absent	49	50.0
Variceal Grade*	Grade I	15	30.6
	Grade II	21	42.9
	Grade III	13	26.5
Acute Variceal Bleed	Yes	12	12.2
	No	86	87.8

*Percentage of variceal grade calculated among patients with varices (n = 49)



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Graph 2: Distribution of Oesophageal Varices and Variceal Grade (N = 98) CLINICAL FEATURES AND SYMPTOMATOLOGY

Frequency of Clinical Signs and Symptoms

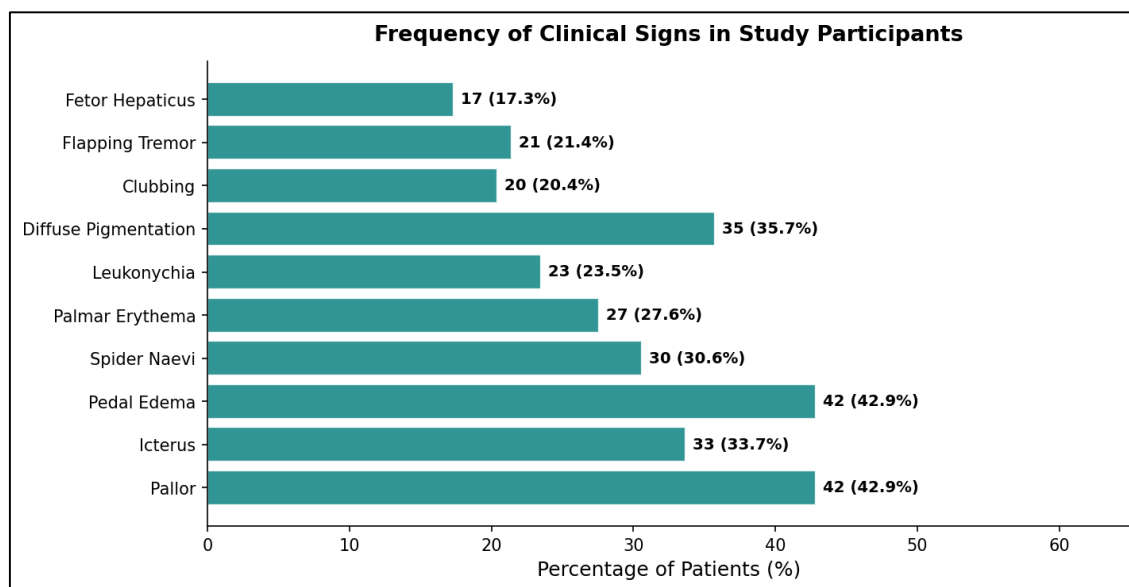
Among 98 cirrhotic patients, pallor and pedal edema were present in 42 patients each (42.9%), followed by ascites in 37 (37.8%), diffuse pigmentation in 35 (35.7%), icterus in 33 (33.7%), and spider naevi in 30 (30.6%). Less frequent findings included leukonychia 23 (23.5%), flapping tremor 21 (21.4%), clubbing 20 (20.4%), and fetor hepaticus 17 (17.3%).

Table 3: Frequency of Clinical Signs and Symptoms (N = 98)

Clinical Sign/Symptom	Present (n)	Percentage (%)	Absent (n)	Percentage (%)
Pallor	42	42.9	56	57.1
Icterus	33	33.7	65	66.3
Pedal Edema	42	42.9	56	57.1
Ascites	37	37.8	61	62.2
Spider Naevi	30	30.6	68	69.4
Palmar Erythema	27	27.6	71	72.4
Diffuse Pigmentation	35	35.7	63	64.3
Leukonychia	23	23.5	75	76.5

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Clubbing	20	20.4	78	79.6
Flapping Tremor	21	21.4	77	78.6
Fetor Hepaticus	17	17.3	81	82.7
Venous Prominence	28	28.6	70	71.4



Graph 3: Frequency of Clinical Signs and Symptoms (N = 98) Comparison of Clinical Signs Between Patients With and Without Varices

Clinical signs were more frequent among patients with varices than those without varices. Icterus was present in 28 (57.1%) versus 5 (10.2%), pedal edema in 31 (63.3%) versus 11

(22.4%), and ascites in 28 (57.1%) versus 9 (18.4%). Pallor, spider naevi, leukonychia, flapping tremor, and fetor hepaticus also showed statistically significant differences with p

< 0.05.

Table 4: Comparison of Clinical Signs Varices vs No Varices (Chi-Square Test)

Clinical Sign	Varices (n=49)	%	No Varices (n=49)	%	p-value	Significance
Pallor	28	57.1	14	28.6	0.0080	Significant
Icterus	28	57.1	5	10.2	<0.0001	Highly Significant
Pedal Edema	31	63.3	11	22.4	0.0001	Highly Significant
Ascites	28	57.1	9	18.4	0.0002	Highly Significant
Spider Naevi	25	51.0	5	10.2	<0.0001	Highly Significant
Palmar Erythema	20	40.8	7	14.3	0.0067	Significant

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Leukonychia	21	42.9	2	4.1	<0.0001	Highly Significant
Diffuse Pigmentation	25	51.0	10	20.4	0.0032	Significant
Clubbing	16	32.7	4	8.2	0.0058	Significant
Flapping Tremor	19	38.8	2	4.1	0.0001	Highly Significant
Fetor Hepaticus	15	30.6	2	4.1	0.0014	Significant

Chi-Square test; $p < 0.05$ considered statistically significant

HEMATOLOGICAL PARAMETERS

Hematological Parameters – Overall Summary

The mean hemoglobin level was 10.78 ± 1.61 g/dL, while mean TLC was $7582 \pm 2162/\mu\text{L}$ and platelet count was $128180 \pm 68396/\mu\text{L}$. Liver function parameters showed mean SGOT 79.60 ± 35.04 U/L, SGPT 77.09 ± 28.23 U/L, ALP 216.82 ± 57.24 U/L, total bilirubin 3.23 ± 1.70 mg/dL, and serum albumin 3.25 ± 0.81 g/dL.

Table 5: Hematological Parameters Overall Summary (N = 98)

Parameter	Mean $\pm$ SD	Median	Minimum	Maximum
Hemoglobin (g/dL)	10.78 ± 1.61	10.85	6.90	14.40
TLC (per μL)	7582 ± 2162	7502	4060	10988
Platelet Count (per μL)	128180 ± 68396	111135	42027	246335
SGOT (U/L)	79.60 ± 35.04	72.00	35.00	158.00
SGPT (U/L)	77.09 ± 28.23	74.00	32.00	146.00
ALP (U/L)	216.82 ± 57.24	215.00	121.00	318.00
Total Bilirubin (mg/dL)	3.23 ± 1.70	3.20	0.80	6.40
Direct Bilirubin (mg/dL)	1.64 ± 0.93	1.50	0.40	3.80
Total Protein (g/dL)	5.82 ± 0.55	5.85	5.00	6.80
Serum Albumin (g/dL)	3.25 ± 0.81	3.25	2.00	4.50

Comparison of Hematological Parameters Between Patients with and Without Varices

Patients with varices had lower hemoglobin 9.52 ± 1.08 g/dL compared to those without varices 12.04 ± 0.91 g/dL, with $p < 0.0001$. Platelet count was also lower in the varices group $64544 \pm 13880/\mu\text{L}$ versus $191817 \pm 31512/\mu\text{L}$. Serum albumin was lower 2.50 ± 0.27 g/dL, while total bilirubin was higher 4.80 ± 1.06 mg/dL, both highly significant.

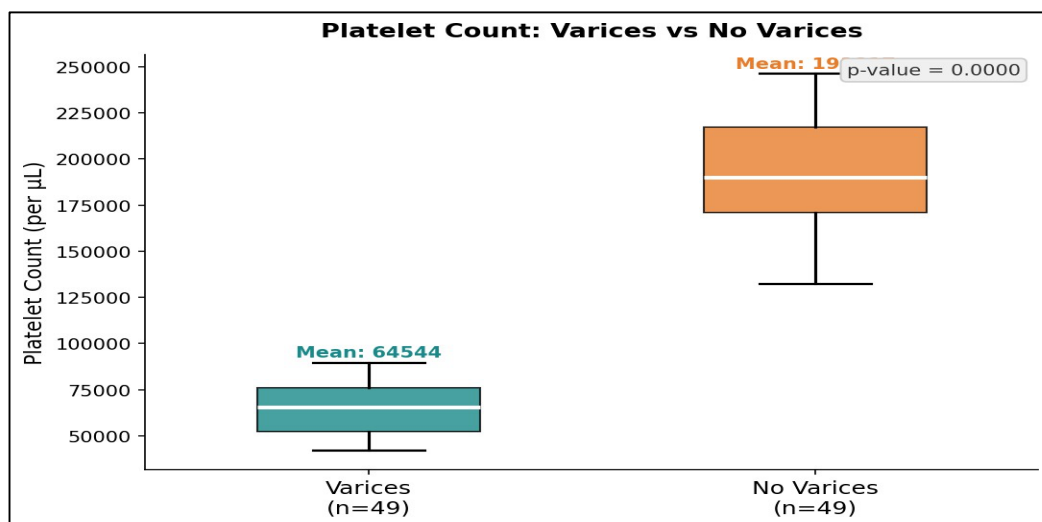
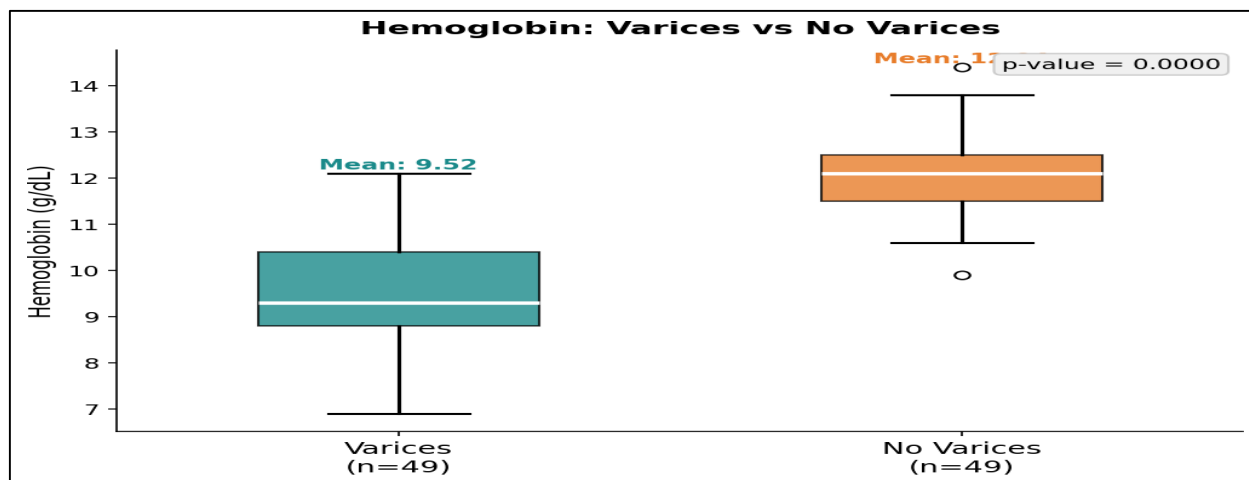
Table 6: Comparison of Hematological Parameters Varices vs No Varices (Mann-Whitney U Test)

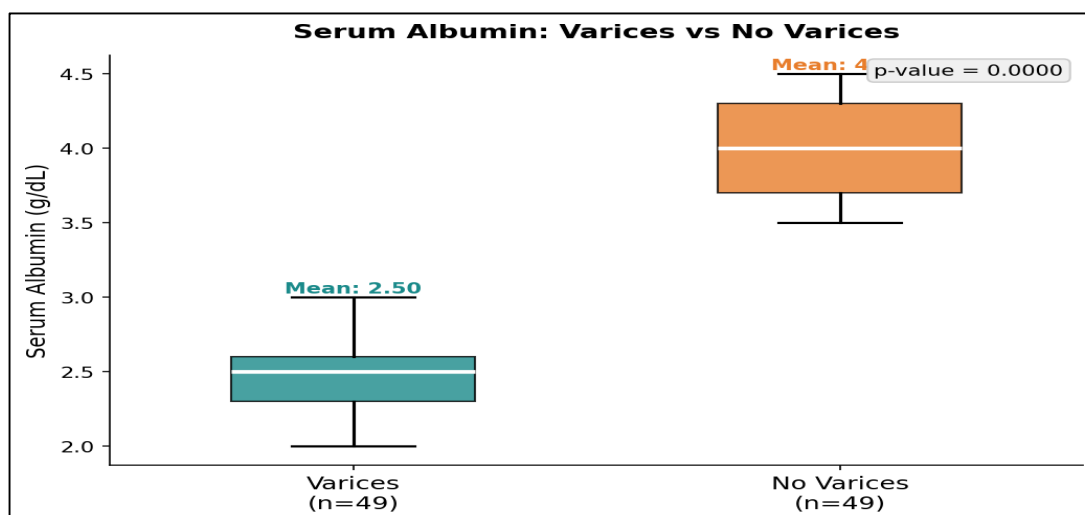
Parameter	Varices (n=49) Mean $\pm$ SD	No Varices (n=49) Mean $\pm$ SD	p-value	Significance
Hemoglobin (g/dL)	9.52 ± 1.08	12.04 ± 0.91	<0.0001	Highly Significant
TLC (per μL)	7261 ± 2204	7903 ± 2093	0.1472	Not Significant
Platelet Count (per μL)	64544 ± 13880	191817 ± 31512	<0.0001	Highly Significant

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Serum Albumin (g/dL)	2.50 ± 0.27	4.00 ± 0.33	<0.0001	Highly Significant
Total Bilirubin (mg/dL)	4.80 ± 1.06	1.66 ± 0.74	<0.0001	Highly Significant

Mann-Whitney U Test used (non-parametric); p < 0.05 considered significant





Graph 4: Comparison of Hematological Parameters Varices vs No Varices (Mann-Whitney U Test)

Radiological Parameters Overall Summary

Among 98 cirrhotic patients, mean portal vein diameter was 13.07 ± 2.35 mm, with a median of 12.55 mm and range 10.00–17.90 mm. Mean spleen diameter was 14.04 ± 2.81 cm, ranging from 10.10–19.90 cm. The mean platelet/spleen diameter ratio was 1028.87 ± 673.36 , with median 874.59 and range 247.21–2259.95.

Table 7: Radiological Parameters Overall Summary (N = 98)

Parameter	Mean $\pm$ SD	Median	Minimum	Maximum
Portal Vein Diameter (mm)	13.07 ± 2.35	12.55	10.00	17.90
Spleen Diameter (cm)	14.04 ± 2.81	13.50	10.10	19.90
Platelet/Spleen Diameter Ratio	1028.87 ± 673.36	874.59	247.21	2259.95

Comparison of Radiological Parameters Between Patients With and Without Varices

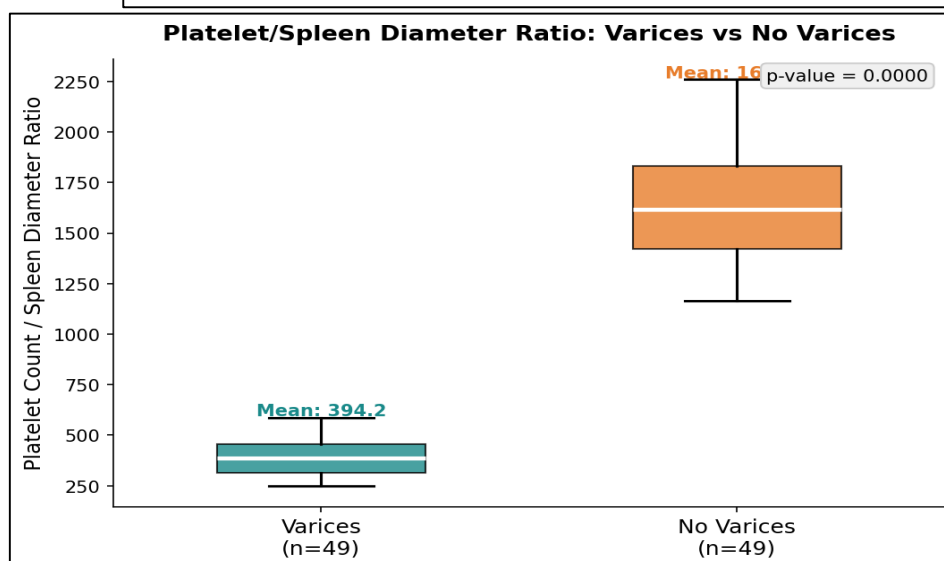
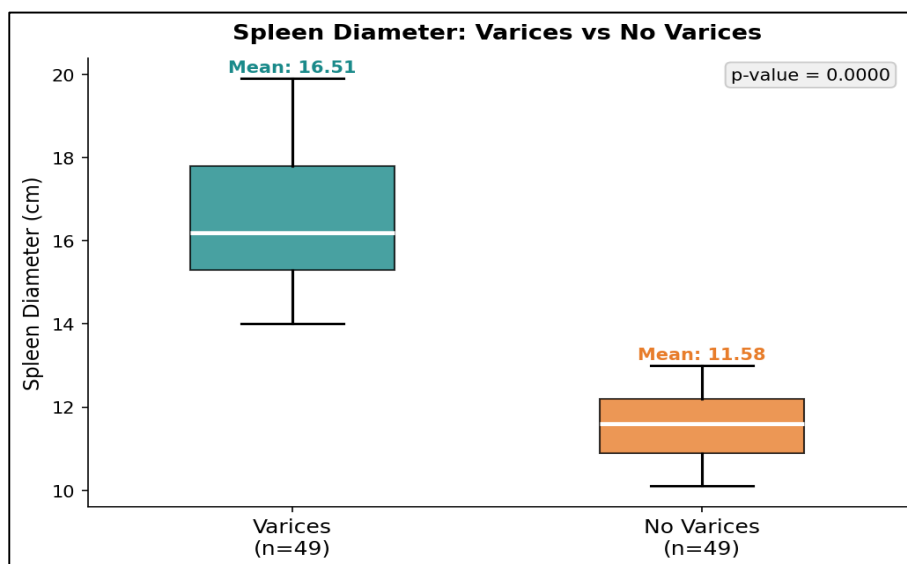
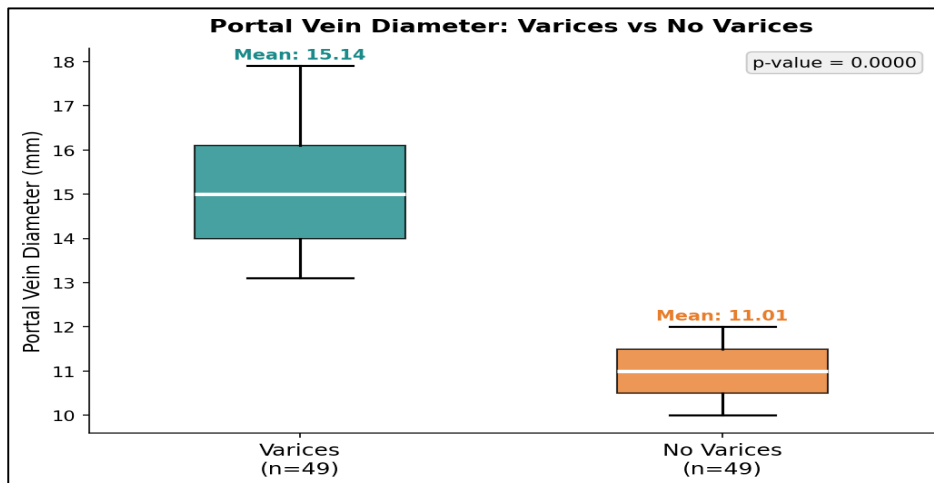
Portal vein diameter was significantly higher in patients with varices 15.14 ± 1.44 mm compared to those without varices 11.01 ± 0.58 mm. Spleen diameter was also higher in the varices group 16.51 ± 1.69 cm versus 11.58 ± 0.80 cm. Platelet/spleen ratio was markedly lower in varices 394.17 ± 91.64 than no varices 1663.57 ± 292.26 , with all parameters showing $p < 0.0001$.

Table 8: Comparison of Radiological Parameters Varices vs No Varices (Mann-Whitney U Test)

Parameter	Varices (n=49) Mean $\pm$ SD	No Varices (n=49) Mean $\pm$ SD	p-value	Significance
Portal Vein Diameter (mm)	15.14 ± 1.44	11.01 ± 0.58	<0.0001	Highly Significant
Spleen Diameter (cm)	16.51 ± 1.69	11.58 ± 0.80	<0.0001	Highly Significant
Platelet/Spleen Ratio	394.17 ± 91.64	1663.57 ± 292.26	<0.0001	Highly Significant

Mann-Whitney U Test used; $p < 0.05$ considered significant

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Graph 5: Comparison of Radiological Parameters Varices vs No Varices (Mann-Whitney U Test)

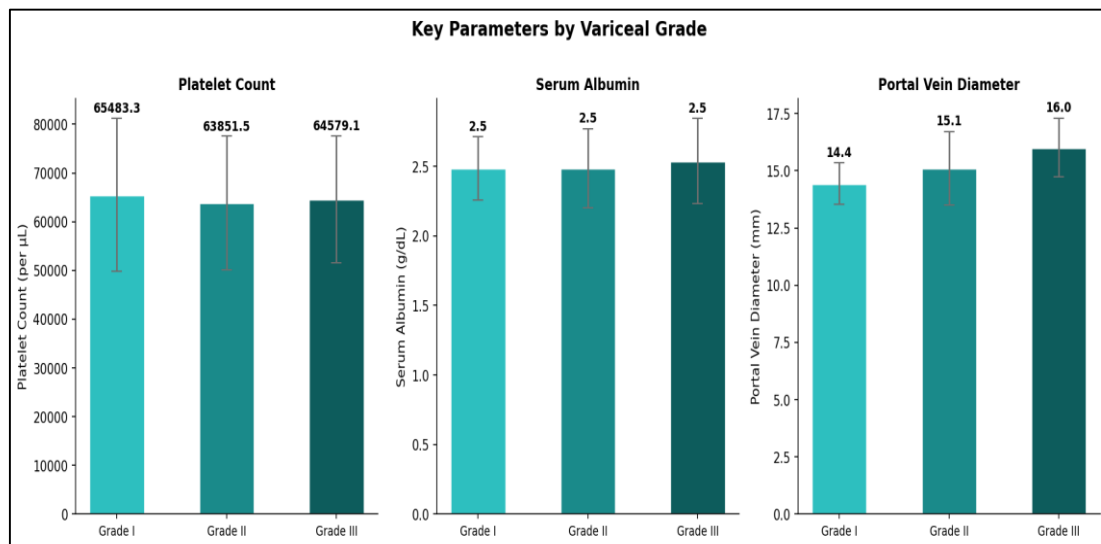
Key Parameters by Variceal Grade

Among 49 patients with varices, portal vein diameter increased from 14.43 ± 0.90 mm in Grade I to 15.10 ± 1.61 mm in Grade II and 16.01 ± 1.28 mm in Grade III, showing statistical significance $p = 0.0204$. Platelet count, serum albumin, spleen diameter, and platelet/spleen ratio did not show significant variation across variceal grades.

Table 9: Key Parameters by Variceal Grade (Among Variceal Patients, n = 49) Kruskal-Wallis Test

Parameter	Grade I (n=15) Mean $\pm$ SD	Grade II (n=21) Mean $\pm$ SD	Grade III (n=13) Mean $\pm$ SD	P-value	Significance
Platelet Count (per μ L)	65483 $\pm$ 15724	63852 $\pm$ 13682	64579 $\pm$ 12970	0.9629	Not Significant
Serum Albumin (g/dL)	2.49 $\pm$ 0.23	2.49 $\pm$ 0.29	2.54 $\pm$ 0.31	0.8410	Not Significant
Portal Vein Diameter (mm)	14.43 $\pm$ 0.90	15.10 $\pm$ 1.61	16.01 $\pm$ 1.28	0.0204	Significant
Spleen Diameter (cm)	17.24 $\pm$ 1.65	15.96 $\pm$ 1.71	16.55 $\pm$ 1.48	0.0687	Not Significant
Platelet/Spleen Ratio	382.58 $\pm$ 100.35	400.93 $\pm$ 82.12	396.64 $\pm$ 101.72	0.8596	Not Significant

Kruskal-Wallis test; $p < 0.05$ considered significant; Portal Vein Diameter increases significantly with variceal grade ($p = 0.0204$)



Graph 6: Key Parameters by Variceal Grade (Among Variceal Patients, n = 49) Kruskal-Wallis Test

Comparison of Parameters Between Acute Variceal Bleed and No Bleed

Patients with acute variceal bleed had lower platelet count $68117 \pm 13555/\mu$ L compared to no bleed $136561 \pm 68807/\mu$ L and lower serum albumin 2.58 ± 0.21 g/dL versus 3.35 ± 0.82 g/dL. Portal vein diameter 15.09 ± 1.39 mm, spleen diameter 16.60 ± 1.67 cm, platelet/spleen ratio 412.65 ± 84.75 , and hemoglobin 10.02 ± 1.06 g/dL showed significant differences, while TLC was not significant.

Table 10: Comparison of Parameters Acute Variceal Bleed vs No Bleed (Mann-Whitney U Test)

Parameter	AVB (n=12) Mean $\pm$ SD	No AVB (n=86) Mean $\pm$ SD	P-value	Significance
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Platelet Count (per μL)	68117 ± 13555	136561 ± 68807	0.0060	Significant
Serum Albumin (g/dL)	2.58 ± 0.21	3.35 ± 0.82	0.0083	Significant
Portal Vein Diameter (mm)	15.09 ± 1.39	12.79 ± 2.32	0.0015	Significant
Spleen Diameter (cm)	16.60 ± 1.67	13.69 ± 2.75	0.0009	Highly Significant
Platelet/Spleen Ratio	412.65 ± 84.75	1114.86 ± 674.84	0.0056	Significant
Hemoglobin (g/dL)	10.02 ± 1.06	10.89 ± 1.65	0.0491	Significant
TLC (per μL)	7332 ± 2469	7617 ± 2130	0.7085	Not Significant

Profile of Acute Variceal Bleed Patients

Among 12 patients with acute variceal bleed, mean platelet count was $68117 \pm 13555/\mu\text{L}$, ranging from 51394–89688/ μL . Mean serum albumin was 2.58 ± 0.21 g/dL, while portal vein diameter was 15.09 ± 1.39 mm. Spleen diameter measured 16.60 ± 1.67 cm, platelet/spleen ratio was 412.65 ± 84.75 , and hemoglobin was 10.02 ± 1.06 g/dL.

Table 11: Profile of Acute Variceal Bleed Patients (n = 12)

Parameter	Value (Mean $\pm$ SD)	Range	Clinical Implication
Platelet Count (per μL)	$68,117 \pm 13,555$	51,394 – 89,688	Severe thrombocytopenia
Serum Albumin (g/dL)	2.58 ± 0.21	2.20 – 2.90	Hypoalbuminaemia
Portal Vein Diameter (mm)	15.09 ± 1.39	13.10 – 17.00	Significant portal hypertension
Spleen Diameter (cm)	16.60 ± 1.67	14.20 – 19.70	Marked splenomegaly
Platelet/Spleen Ratio	412.65 ± 84.75	293.75 – 586.20	High bleed risk (<909 threshold)
Hemoglobin (g/dL)	10.02 ± 1.06	8.10 – 12.10	Moderate anaemia

DISCUSSION

Platelet Count

Platelet count was one of the strongest hematological markers associated with oesophageal varices in the present study. The overall mean platelet count was $128180 \pm 68396/\mu\text{L}$. Patients with varices had significantly lower platelet counts than those without varices (64544 ± 13880 vs. $191817 \pm 31512/\mu\text{L}$; $p < 0.0001$). Similarly, patients with acute variceal bleeding had significantly lower platelet counts than those without bleeding (68117 ± 13555 vs. $136561 \pm 68807/\mu\text{L}$; $p = 0.0060$). Zaman et al. identified platelet count $\leq 90 \times 10^3/\mu\text{L}$ as an independent predictor of any varices and $\leq 80 \times 10^3/\mu\text{L}$ for large varices [11]. Jeon et al. and Cherian et al. also reported low platelet count as an independent predictor of oesophageal varices [12,13]. Kumar et al. similarly demonstrated a significant association between thrombocytopenia and large oesophageal varices [14]. These findings support platelet count as a simple, routinely available marker for

identifying cirrhotic patients at increased risk of varices and bleeding.

Serum Albumin

Serum albumin was significantly associated with both variceal presence and acute variceal bleeding. The overall mean albumin was 3.25 ± 0.81 g/dL. Patients with varices had markedly lower albumin than those without varices (2.50 ± 0.27 vs. 4.00 ± 0.33 g/dL; $p < 0.0001$). Albumin was also significantly lower among patients with acute variceal bleeding (2.58 ± 0.21 vs. 3.35 ± 0.82 g/dL; $p = 0.0083$). Jeon et al. reported serum albumin as significantly associated with oesophageal varices [12], while Berzigotti et al. incorporated albumin into non-invasive models for clinically significant portal hypertension and oesophageal varices [15]. Thabut et al. demonstrated significant differences in Child-Pugh class between patients with and without large varices, while Cherian et al. identified Child-Pugh B/C as an independent predictor of varices and large varices

[16,13]. Thus, hypoalbuminemia in the present study reflects advanced hepatic dysfunction and identifies patients requiring closer assessment for varices and bleeding.

Total Bilirubin

Total bilirubin was significantly higher in patients with oesophageal varices. The overall mean total bilirubin was 3.23 ± 1.70 mg/dL, while patients with varices had significantly higher levels than those without varices (4.80 ± 1.06 vs. 1.66 ± 0.74 mg/dL; $p < 0.0001$). Jeon et al. similarly found total bilirubin to be significantly associated with oesophageal varices on univariate analysis [12]. Previous studies have also emphasized liver dysfunction parameters, including albumin, INR, ALT, and Child-Pugh class, in the assessment of portal hypertension and variceal risk [16,15]. The marked hyperbilirubinemia observed in the variceal group therefore supports the association between worsening hepatic dysfunction and oesophageal varices.

Hemoglobin

Hemoglobin was significantly lower in patients with varices and in those with acute bleeding. The overall mean hemoglobin was 10.78 ± 1.61 g/dL. Patients with varices had lower hemoglobin than those without varices (9.52 ± 1.08 vs. 12.04 ± 0.91 g/dL; $p < 0.0001$). Patients with acute variceal bleeding also had significantly lower hemoglobin than those without bleeding (10.02 ± 1.06 vs. 10.89 ± 1.65 g/dL; $p = 0.0491$). Although the comparative studies primarily emphasized platelet count and liver dysfunction rather than hemoglobin, the present finding indicates that anemia may contribute to recognition of patients with clinically significant variceal disease and bleeding. It may reflect acute or chronic gastrointestinal blood loss, hypersplenism, or anemia associated with advanced liver disease.

Portal Vein Diameter

Portal vein diameter was a significant radiological marker of oesophageal varices and variceal severity. The overall mean portal vein diameter was 13.07 ± 2.35 mm. Patients with varices had significantly larger portal veins than those without varices (15.14 ± 1.44 vs. 11.01 ± 0.58 mm; $p < 0.0001$). Importantly, portal vein diameter increased progressively with variceal grade, from 14.43 ± 0.90 mm in Grade I to 15.10 ± 1.61 mm in Grade II and 16.01 ± 1.28 mm in Grade III ($p = 0.0204$). It was also significantly higher in patients with acute variceal bleeding than in those without bleeding (15.09 ± 1.39 vs. 12.79 ± 2.32 mm; $p = 0.0015$). Jeon et al. reported significantly greater portal vein diameter in patients with varices [12]. Hong et al. identified portal vein diameter and spleen width as independent predictors, with a combined model showing 87.2% sensitivity and 80.1% accuracy [17]. Cherian et al. also identified portal vein diameter as an independent predictor of varices [13], while Kumar et al. found it significantly associated with large varices [14]. The present findings therefore support

portal vein diameter as an important non-invasive marker of both variceal presence and severity.

Spleen Diameter

Spleen diameter was significantly associated with oesophageal varices and acute variceal bleeding. The overall mean spleen diameter was 14.04 ± 2.81 cm. Patients with varices had significantly greater spleen diameter than those without varices (16.51 ± 1.69 vs. 11.58 ± 0.80 cm; $p < 0.0001$). Patients with acute bleeding also had significantly greater spleen diameter than those without bleeding (16.60 ± 1.67 vs. 13.69 ± 2.75 cm; $p = 0.0009$). Jeon et al. reported significantly increased spleen diameter in patients with varices and found a cut-off of 11 cm to have 84% sensitivity and 63% specificity [12]. Cherian et al. identified spleen diameter as an independent predictor of varices and large varices [13], while Kumar et al. also reported a significant association between spleen size and large oesophageal varices [14]. These findings support splenomegaly as an important indicator of portal hypertension and increased variceal risk.

Platelet/Spleen Diameter Ratio

The platelet/spleen diameter ratio demonstrated a strong association with variceal presence and acute bleeding. The overall mean ratio was 1028.87 ± 673.36 . Patients with varices had a markedly lower ratio than those without varices (394.17 ± 91.64 vs. 1663.57 ± 292.26 ; $p < 0.0001$). Similarly, patients with acute bleeding had a significantly lower ratio than those without bleeding (412.65 ± 84.75 vs. 1114.86 ± 674.84 ; $p = 0.0056$). Jeon et al. identified platelet count/spleen diameter ratio as an independent predictor of oesophageal varices [12]. Sharma et al. reported that a platelet-to-spleen ratio ≤ 909 predicted oesophageal varices [18], while Abraldes et al. demonstrated the usefulness of platelet-spleen and liver stiffness-based ratios for stratifying clinically significant portal hypertension [19]. The markedly reduced ratio in the present study therefore supports its utility as a simple combined hematological-radiological screening marker.

Acute Variceal Bleeding

Acute variceal bleeding was present in 12 patients (12.2%). These patients demonstrated a characteristic high-risk profile, with lower platelet count ($68117 \pm 13555/\mu\text{L}$), lower serum albumin (2.58 ± 0.21 g/dL), lower hemoglobin (10.02 ± 1.06 g/dL), larger portal vein diameter (15.09 ± 1.39 mm), greater spleen diameter (16.60 ± 1.67 cm), and lower platelet/spleen ratio (412.65 ± 84.75). All these parameters, except total leukocyte count, showed significant differences between patients with and without acute bleeding. Sharma et al. demonstrated that spleen stiffness was associated with large varices and previous variceal bleeding, with spleen stiffness ≥ 40.8 kPa predicting oesophageal varices with 94% sensitivity and 76% specificity [18]. Yang et al. developed a model for high bleeding-risk oesophageal varices with an AUC of 0.965, demonstrating excellent discriminatory ability [20]. The present findings

similarly indicate that a combination of thrombocytopenia, hypoalbuminemia, anemia, portal vein dilatation, splenomegaly, and a low platelet/spleen ratio identifies cirrhotic patients at increased risk of acute variceal bleeding.

Overall Interpretation

The present study demonstrates that **platelet count, serum albumin, total bilirubin, hemoglobin, portal vein diameter, spleen diameter, and platelet/spleen diameter ratio** are the most clinically relevant parameters associated with oesophageal varices and acute variceal bleeding. Among the radiological parameters, portal vein diameter additionally demonstrated a significant progressive increase across variceal grades, suggesting potential value in assessing severity. In contrast, platelet count, albumin, spleen diameter, and platelet/spleen ratio were more useful for distinguishing patients with and without varices than for differentiating individual variceal grades. The concordance of these findings with previous studies supports their use as accessible, non-invasive markers for identifying high-risk cirrhotic patients and prioritizing endoscopic evaluation.

CONCLUSION

Overall, this study concludes that platelet count, serum albumin, total bilirubin, hemoglobin, portal vein diameter, spleen diameter, and platelet-to-spleen diameter ratio are significantly associated with oesophageal varices and acute variceal bleeding in cirrhotic patients. Although upper gastrointestinal endoscopy remains the gold standard for diagnosis and grading, these accessible, cost-effective, and non-invasive parameters can help identify high-risk patients, prioritize endoscopic screening, and facilitate timely prophylactic therapy. A structured assessment incorporating clinical examination, complete blood count, liver function tests, and abdominal ultrasonography may therefore provide a practical approach for early identification and management of patients at risk of varices and their life-threatening complications, particularly in resource-limited settings.

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