The Egyptian Journal of Hospital Medicine (January 2024) Vol. 94, Page 777-784

Evaluation of Baveno VII Criteria in Ruling out High Risk Varices in Cirrhotic Egyptian Patients

Badawy A. Abdulaziz[1], Magdy AbdelMawgoud Gad[1], Ahmed Mohamed Edrees[2], Ahmed Esmat ElAshry*[1], Ahmed S. Elgazar[1]

[1]Hepatology, Gastroenterology and Infectious Diseases Department, Faculty of Medicine, Benha University, Egypt
[2]Hepatology and Gastroenterology Department, National Liver Institute, Menoufia University, Egypt
***Corresponding author:** Ahmed Esmat El Ashry, **Mobile:** (+20) 1000199299, **E-Mail**: drahmadesmat@gmail.com

ABSTRACT

Background: Most serious complications of liver cirrhosis, including ascites, esophageal varices (EV), and variceal hemorrhage, are brought on by portal hypertension. It has been suggested that screening with a gastroscopy be used to evaluate EV and bleeding risk in patients with cirrhosis. Gastroscopy, however, is a costly and intrusive surgery that carries some risk. Esophageal varices and high-risk varices have been identified or ruled out using noninvasive screening techniques such as liver and spleen stiffness.

Objective: Our goal was to confirm that, in Egyptian cirrhotic individuals, spleen stiffness, liver stiffness, and platelet count (PLT) can be used to rule out high-risk varices.

Subjects and Methods: A total of 155 individuals with liver cirrhosis were included in cross-sectional study based on whether they had esophageal varices or not using esophagogastroduodenoscopy. The patients were sorted into three distinct groups according to the degree of varices: Those without varices, those with low-risk varices, and those with high-risk varices.

Results: It was observed that the high-risk varices group had greater liver and spleen stiffness measurements than the no varices and low risk varices groups. Spleen stiffness at a cut-off level of < 45 kpa is optimum in ruling out high risk varices (HRV) with 93.85% sensitivity, 96.67% specificity 95.3% PPV and 95.6% NPV with P value <0.001 and AUC of 0.981, while liver stiffness for ruling out HRV, the optimum cut-off level was < 29.1 kpa with 71.11% sensitivity, 95.38% specificity, 95.52% PPV and 70.45% NPV with P value <0.001 and AUC of 0.886. Platelets at a cut-off level <93 can rule out HRV with 84.44% sensitivity, 96.92% specificity, 97.44% PPV and 81.82% NPV with P value <0.001 and AUC=0.898.

Conclusions: In Egyptian cirrhotic individuals, spleen stiffness in addition to liver stiffness and PLT may be helpful in ruling out high-risk varices, which is consistent with the Baveno VII criteria.

Keywords: Baveno VII criteria, Cirrhotic, Egyptian, High-risk varices, Spleen stiffness.

INTRODUCTION

Cirrhosis stands as one of the predominant causes of mortality worldwide, particularly in developing nations, where the 1-year mortality rate varies between 1 to 57% based on the stage [(1)]. Individuals with cirrhosis necessitate frequent medical assistance, leading to a substantial healthcare burden. Cirrhosis, beyond being a chronic and progressive liver ailment, encompasses multifactorial immune dysfunction. This dysfunction involves uncontrolled cytokine secretion, reduced phagocytosis by the innate immune system, and aberrant responses from T and B cells during pathogen stimulation [(2)]. Gastroesophageal varices (GEV) and variceal hemorrhage (VH) serve as significant clinical milestones in the natural course of cirrhosis, potentially indicating various stages of disease progression and a substantial correlation between portal hypertension severities. Variceal hemorrhage (VH), in particular, stands out as a clinical consequence characterizing cirrhosis decompensation, representing a potentially fatal complication of the condition [(3)].

The incidence of esophageal varices (up to 62%) and big varices (up to 47%) was considerably greater in Egyptian patients with HCV who also had liver cirrhosis. The conventional technique for assessing portal pressure is the hepatic venous pressure gradient (HVPG) evaluation; readings more than 10 mmHg are associated with a higher risk of high-risk GEV. Varices are highly connected with the HVPG in terms of both frequency and magnitude, but measuring it requires an intrusive process, hence it is not used frequently [(4)].

Esophageal varices, which indicate stage 2 in the illness's natural history, occur in patients with compensated cirrhosis at a yearly rate of 7% to 8%. A transition to decompensated cirrhosis (state 3 in the typical course of cirrhosis) is indicated by bleeding in 5%–15% of patients' year after they first appear [(5)]. There is a 20% higher risk of death for those who bleed. Esophageal varices should be examined in patients with cirrhosis to avoid bleeding, and primary prophylaxis against rupture should be administered to those who are more vulnerable [(6)].

The Baveno VI criteria, incorporating a liver stiffness measurement (LSM) of ≤20 kPa through transient elastography (TE) and a platelet count (PLT) of ≥150 × 10^9/L, has been thoroughly validated as a reliable non-invasive tool for anticipating a low likelihood of clinically significant varices. Consequently, this obviates the necessity for invasive endoscopic investigation concerning esophageal varices (OV). The updated Baveno VII consensus extends its scope to encompass the diagnosis of

Received: 16/10/2023
Accepted: 17/12/2023

compensated advanced chronic liver disease (cACLD) and clinically significant portal hypertension (CSPH). This expanded application enables the anticipation of the risk associated with developing decompensated liver disease and variceal hemorrhage [(7)]. The Baveno VII criteria advocates for patients with a liver stiffness measurement (LSM) of ≤15 kPa and a platelet count (PLT) exceeding 150 × 10^9/L, suggesting a >90% likelihood of excluding clinically significant portal hypertension (CSPH). This clinical insight implies a low probability of high-risk varices, thus eliminating the necessity for screening endoscopy until yearly follow-up LSM readings reach ≥20 kPa and/or PLT levels decline to ≤150 × 10^9/L. Additionally, it suggests that an LSM exceeding 25 kPa is adequate for diagnosing CSPH. Although the Baveno VII consensus applies to all patients with liver cirrhosis, its utilization in advanced hepatocellular carcinoma (HCC) patients remains less defined [(8)].

There is no data supporting or validating these criteria in Egyptian patients, which promote us to perform this study so that patients can benefit from skipping invasive screening procedures when unnecessary.

PATIENTS AND METHODS

A set of 155 patients with liver cirrhosis (diagnosed by imaging, laboratory, and clinical studies) who attended the Outpatient Clinics for Hepatology, Gastroenterology, and Infectious Diseases at the National Liver Institute at Menoufia University between November 2022 and May 2023 were included in this prospective cross-sectional study.

Exclusion criteria: Non-cirrhotic portal hypertension, splenectomy, acute or chronic portal vein thrombosis, liver transplantation, transjugular intrahepatic portosystemic shunt (TIPS) procedure, hepatic encephalopathy, non-selective beta blocker treatment, variceal bleeding or band ligation, and HCC.

Three groups of the studied patients were constituted: **Group I** comprised thirty patients who had no varices. Sixty patients with low-risk varices were involved in **Group II**. Sixty-five patients with high-risk varices were enrolled in **Group III**.

A complete history was obtained from each patient, encompassing details such as name, age, gender, medical history and past illnesses. A thorough clinical examination was done to every patient enrolled in the study with special attention to the symptoms of portal hypertension (such as ascites, jaundice, splenomegaly, etc.) and the stigmata associated with liver cell failure. CBC, KFT, LFT (albumin, ALP, AST, total and direct bilirubin, and viral markers such as HBVs Ag and HCV-Ab) were among the laboratory tests conducted.

To evaluate cirrhosis, focal lesions, portal vein patency, spleen size, and ascites, abdominal ultrasonography was done. One proficient operator performed transient elastography (TE) of the liver and spleen using an Echosense 502 Fibroscan device equipped with an M-probe. The patient needed to be supine, in the maximum abduction posture, and fasting for a minimum of six hours. To avoid the spleen capsule for spleen stiffness measurement and the right liver lobe for liver stiffness measurement, the TE was performed using an intercostal route in the superior pole of the spleen. The measurements were conducted in accordance with the "Elastica" Liver Stiffness Study Group of the Italian Association for the Study of the Liver. Ten successful measures were implemented for each patient. A success rate of more than 60% and an interquartile range/median of less than 30% were deemed sufficient quality requirements for TE.

Using the Pentax EPK-i5000 endoscopy, a skilled gastroenterologist performed an upper gastrointestinal endoscopy. The assessment involved the identification and severity assessment of esophageal varices, which were then classified based on their dimensions: small varices were small and linear, medium varices were enlarged and tortuous, substantial varices were big, coil-shaped varices that took up less than one third of the lumen [(9)].

Ethical approval: The subject was given a detailed explanation of the study's aims before signing an informed consent form. The consent form was prepared in accordance with the Quality and Improvement System's criteria and the Helsinki Declaration. The study proposal was authorised by The Local Ethical Scientific Committee of Egypt's Benha University, Faculty of Medicine (MS 55-10-2022).

Statistical Analysis

SPSS version 27.0 (IBM©, Chicago, IL, USA) was used to analyse the data. Histograms and the Shapiro-Wilks test were used to determine whether the data distribution was normal. Both the post hoc Tukey test and the ANOVA (F) test were used to assess quantitative parametric data. Mean ± SD of the results were given. Based on quantitative non-parametric data, the Mann Whitney and Kruskall-Wallis tests were utilised to compare each group. The IQR and median of the data were provided. We looked at the frequency and percentage (%) of the qualitative variables using the Chi-square test. ROC-curve analysis is used to calculate a diagnostic test's PPV, NPV, specificity, and sensitivity. When a p-value is equal to or less than 0.05, it is deemed significant.

RESULTS

A total of 155 patients with liver cirrhosis were enrolled in our study, 126 of them were males, the mean age was 65 ± 8.06 years, 140 of them were HCV-induced cirrhosis and 15 were due to chronic HBV. There was no statistically significant difference regarding sociodemographic characteristics among studied groups (Table 1).

Table (1): Sociodemographic characteristics and viral hepatitis status among studied groups

		Overall (n=155)	No varices (n=30)	LRV (n=60)	HRV (n=65)	P value
Age (years)	Mean ± SD	65 ± 8.06	52.8 ± 6.36	55 ± 9.02	55.5 ± 9.4	0.371
	Range	51 - 81	40 - 63	32 - 70	27 - 70	
Sex	Male	126 (81.29%)	25 (83.33%)	48 (80%)	53 (81.54%)	0.927
	Female	29 (18.71%)	5 (16.67%)	12 (20%)	12 (18.46%)	
BMI (kg/m^2)	Mean ± SD	23.6 ± 3.91	23.5 ± 4.57	23.3 ± 3.96	24 ± 3.56	0.813
	Range	17 - 33.3	17 - 33.3	17.2 - 32	17.2 - 30.9	
Viral hepatitis	HBV	15 (9.68%)	3 (10%)	5 (8.33%)	7 (10.77%)	0.898
	HCV	140 (90.32%)	27 (90%)	55 (91.67%)	58 (89.23%)	

*HCV: hepatitis C virus, HBV: hepatitis B virus

Regarding the comorbidities, liver span, and spleen size of the study group, it was found that there were significant differences (p<0.001) in splenomegaly and spleen size across the three groups. Spleen size was significantly higher in LRV group (15.1 ± 1.13) and HRV group (16.3 ± 1.36) than in no varices group (12 ±1.05) and higher in HRV than in LRV (P<0.001). There was no statistically significant difference in liver span across all patient groups (Table 2).

Table (2): Comorbidities, spleen size and liver span of the studied groups:

		Overall (n=155)	No varices (n=30)	LRV (n=60)	HRV (n=65)	P value	
Hypertension	Yes	53 (34.19%)	8 (26.67%)	21 (35%)	24 (36.92%)	0.610	
	No	102 (65.81%)	22 (73.33%)	39 (65%)	41 (63.08%)		
DM	Yes	34 (21.94%)	5 (16.67%)	13 (21.67%)	16 (24.62%)	0.683	
	No	121 (78.06%)	25 (83.33%)	47 (78.33%)	49 (75.38%)		
Splenomegaly	Yes	60 (38.71%)	5 (16.67%)	21 (35%)	34 (52.31%)	0.003*	
	No	95 (61.29%)	25 (83.33%)	39 (65%)	31 (47.69%)		
Spleen size (cm)	Mean ± SD	15 ± 1.98	12 ± 1.05	15.1 ± 1.13	16.3 ± 1.36	<0.001*	P1<0.001*
	Range	10.5 - 18.7	10.5 - 14	13.1 - 17	14 - 18.7		P2<0.001*
							P3<0.001*
Liver span (cm)	Mean ± SD	10.69± 0.46	10.8 ± 0.28	10.7 ± 0.41	10.6 ± 0.54	0.068	
	Range	9.1 – 11.5	10.5 - 11.5	10 - 11.4	9.1 - 11.2		

*: Significant as p value ≤0.05, P1: P value between no varices and LRV, P2: P value between no varices and HRV, P3: P value between LRV and HRV, LRV: Low risk varices, HRV: High risk varices.

Regarding bilirubin and INR levels, a statistically significant difference was found to be higher in the high-risk varices group than the in the low-risk varices group (P <0.001). Additionally, compared to LRV and HRV, albumin was statistically significant higher in the no varices group (P <0.001). Regarding ALT and AST, there was no statistically significant difference between the studied groups (Table 3).

Table (3): Liver profile test of the studied groups

		Overall (n=155)	No varices (n=30)	LRV (n=60)	HRV (n=65)	P value	Post hoc
ALT (U/L)	Mean ± SD	73.4 ± 4.03	71.1 ± 3.77	77.4 ± 7.12	70.7 ± 4.5	0.641	
AST (U/L)	Mean ± SD	76.7 ± 18.43	74.8 ± 16.81	83.2 ± 19.21	71.5 ± 15.32	0.249	
Total serum bilirubin (mg/dl)	Mean ± SD	1.3 ± 0.31	0.8 ± 0.17	1.2 ± 0.28	1.6 ± 0.37	<0.001*	P1=0.011* P2<0.001* P3=0.001*
Direct serum bilirubin (mg/dl)	Mean ± SD	0.7 ± 0.15	0.4 ± 0.10	0.7 ± 0.14	0.9 ± 0.21	<0.001*	P1=0.018* P2<0.001* P3<0.001*
Serum albumin (g/dl)	Mean ± SD	3.1 ± 0.46	3.4 ± 0.35	3.1 ± 0.45	2.9 ± 0.4	<0.001*	P1=0.003* P2<0.001* P3=0.002*
INR	Mean ± SD	1.4 ± 0.23	1.2 ± 0.17	1.4 ± 0.18	1.6 ± 0.11	<0.001*	P1<0.001* P2<0.001* P3<0.001*

*: Significant as p value ≤0.05, P1: P value between no varices and LRV, P2: P value between no varices and HRV, P3: P value between LRV and HRV, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, INR: International normalized ratio, LRV: Low risk varices, HRV: High risk varices.

Also, WBCs and platelets showed statistically significant differences (P<0.001) among the three groups, while Hb was not significantly different across all groups. WBCs and platelets were shown to be considerably higher in no varices group compared to LRV and HRV groups (P<0.05), and significantly higher in LRV than in HRV (P<0.001) (Table 4).

Table (4): Complete blood count of the studied groups

		Overall (n=155)	No varices (n=30)	LRV (n=60)	HRV (n=65)	P value	Post hoc
Hb (gm/dl)	Mean ± SD	13 ± 1.09	13.3 ± 1.15	13.1 ± 1.1	12.8 ± 1.02	0.137	
WBCs (× 10^9/L)	Mean ± SD	6.1 ± 1.42	7.6 ± 1.88	6.5 ± 1.61	5.1 ± 1.26	<0.001*	P1=0.004* P2<0.001* P3<0.001*
PLT (× 10^9/L)	Mean ± SD	95.37 ± 21.2	118.8 ± 9.68	106.3 ± 11.09	74.5 ± 10.61	<0.001*	P1< 0.001* P2<0.001* P3<0.001*

*: Significant as p value ≤0.05, P1: P value between no varices and LRV, P2: P value between no varices and HRV, P3: P value between LRV and HRV, WBCs: White blood cells, PLT: Platelets, LRV: Low risk varices, HRV: High risk varices.

Table (5) demonstrated esophageal varices grading, thirty patients (19.35%) had no varices, sixty patients (38.71%) had low risk varices, and sixty-five patients had high risk varices. The patients were divided into three groups, twenty-five patients had medium varices, thirty patients had large varices, and ten patients had small risky varices.

Table (5): Esophageal varices grading of the studied groups.

		N (155)
No varices		30 (19.35%)
Low risk varices	Small non risky varices	60 (38.71%)
High risk varices	Medium varices	25 (16.13%)
	Large varices	30 (19.35%)
	Small risky	10 (6.45%)

Liver stiffness was statistically significant lower in no varices group (24.9 ± 2.68 kpa) than in low-risk varices group (29.4 ± 5.54 kpa) and high-risk varices group (38.6 ± 9.26) with P<0.001 (table 6).

Table (6): Liver stiffness of the studied groups

		No varices (n=30)	Low risk varices (n=60)	High risk varices (n=65)	P value	Post Hoc
Liver stiffness (kpa)	Mean ± SD	24.9 ± 2.68	29.4 ± 5.54	38.6 ± 9.26	<0.001*	P1<0.001* P2<0.001* P3<0.001*
	Range	21.1 - 31.9	21.1 - 45.1	26.2 - 66.5		

*: Significant as p value ≤0.05, P1: P value between No varices and Low risk varices, P2: P value between No varices and High-risk varices, P3: P value between low-risk varices and high-risk varices.

Spleen stiffness was statistically significant higher in patients with HRV than in patients with LRV and patients with no varices (64.2±11.44 kpa, 41.6±4.14 kpa and 30.2±3.31 kpa, respectively) with P<0.001 (table 7).

Table (7): Spleen stiffness of the studied groups

		No varices (n=30)	Low risk varices (n=60)	High risk varices (n=65)	P value	Post Hoc
Spleen stiffness (kpa)	Mean ± SD	30.2 ± 3.31	41.6 ± 4.14	64.2 ± 11.44	<0.001*	P1<0.001* P2<0.001* P3<0.001*
	Range	23 - 37	30 - 46	35 - 79		

*Significant as p value ≤0.05, P1: P value between No varices and Low risk varices, P2: P value between No varices and High-risk varices, P3: P value between Low-risk varices and High-risk varices.

Table (8) demonstrated the univariate and multivariate regression analysis of different variables to rule out HRV in cirrhotic patients. In univariate regression analysis, it was discovered that the following factors independently predicted high-risk varices: serum albumin, INR, total serum bilirubin, direct serum bilirubin, spleen stiffness, PLT, WBCs, and liver stiffness (P<0.001). In multivariate regression analysis, the only independent predictors of high-risk factors (P<0.05) were spleen stiffness, liver stiffness, PLTs and INR.

Table (8): Univariate and multivariate regression analysis of different variables to rule out HRV in cirrhotic patients

	Univariate			Multivariate		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Liver stiffness (kPa)	1.438	1.24 - 1.66	<0.001*	1.390	1.08 -1.77	0.008*
Spleen stiffness (kPa)	1.8245	1.21 -2.74	<0.001*	1.770	1.19 - 2.63	0.003*
PLT ($\times 10^9$/L)	0.8848	0.84- 0.92	<0.001*	0.900	0.83- 0.96	0.004*
WBCs ($\times 10^9$/L)	0.550	0.41 -0.73	<0.001*	0.725	0.47 -1.10	0.132
Total serum bilirubin (mg/dl)	16.767	4.38 - 64.08	<0.001*	4.570	0.88 -23.70	0.070
Direct Serum Bilirubin (mg/dl)	30.294	6.575 - 139.57	<0.001*	0.6921	0.04 - 10.63	0.791
Serum albumin (g/dl)	0.057	0.01- 0.20	<0.001*	0.1825	0.02 - 1.47	0.111
INR	3266.422	165.218 - 64578.38	<0.001*	271.19	4.36 -16830.34	0.006*

*Significant as P value≤0.05, CI: Confidence interval.

Spleen stiffness, with a cutoff value of <45 kpa, demonstrated a sensitivity of 93.85%, specificity of 96.67%, positive predictive value (PPV) of 95.3%, negative predictive value (NPV) of 95.6%, and an area under the curve of 0.983. These metrics highlight spleen stiffness as an exceptional means for ruling out high-risk varices (HRV). Conversely, liver stiffness, with a cutoff value of < 29.1, exhibited a sensitivity of 71.11%, specificity of 95.38%, PPV of 95.52%, NPV of 70.45%, and an area under the curve of 0.886, positioning it as a good tool for ruling out HRV. Notably, spleen stiffness emerged as a superior tool for HRV exclusion compared to liver stiffness. (Table 9 and Figure 1).

Table (9): Role of different non-invasive tools to rule out HRV in cirrhotic patients

	Liver stiffness	Spleen stiffness	Platelets	INR
Cut-off	<29.1	<45	≥93	<1.4
Sensitivity	71.11%	93.85 %	84.44%	64.44%
Specificity	95.38%	96.67 %	96.92%	96.92%
PPV	95.52%	95.3 %	97.44%	96.67%
NPV	70.45%	95.6 %	81.82%	66.32%
AUC	0.886	0.983	0.898	0.919
P value	<0.001*	<0.001*	<0.001*	<0.001*

*: Significant as P value ≤0.05, PPV: positive predictive value, NPV: negative predictive value, AUC: area under the curve

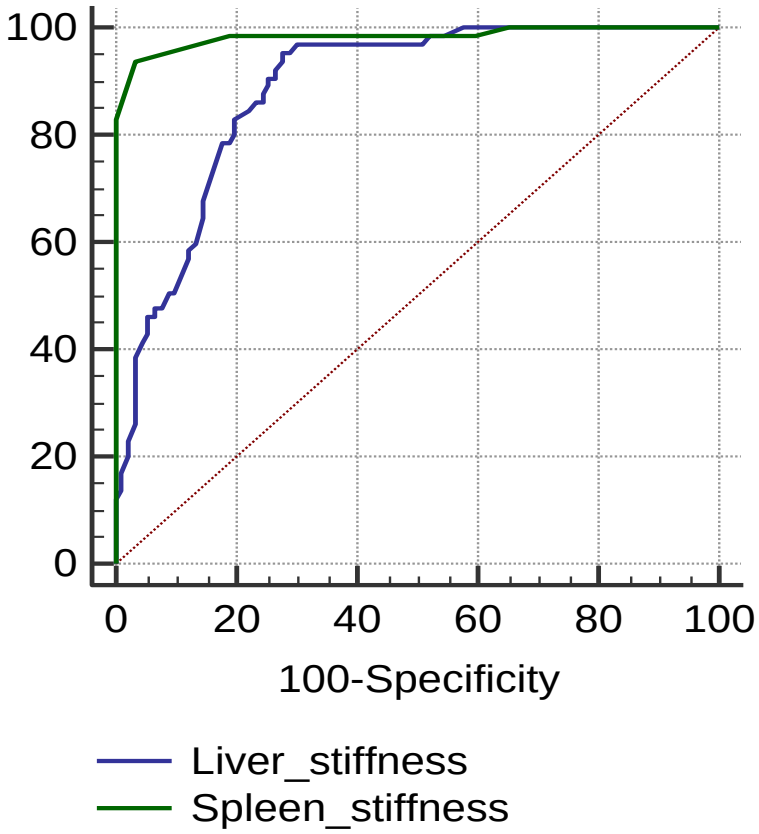

Figure (1): ROC curve of liver stiffness and spleen stiffness in rule out high-risk varices.

DISCUSSION

Most severe liver cirrhosis sequelae, including ascites, EV, and esophagogastric variceal bleeding (EVB), are mostly caused by portal hypertension [(10)]. Patients with liver cirrhosis are at high risk for developing EVB, a condition that is linked to a high death rate. Thus, HRV screening is required for cirrhotic patients receiving treatment [(11)]. According to **Garcia-Tsao *et al.*** [(12)], a gastroscopy should be part of the screening process for EV and bleeding risk assessment. But a gastroscopy is an invasive procedure that is intrusive, costly, and possibly hazardous [(13)].

Over the last decade, developments in non-invasive diagnostic methods have resulted in a rise in the proportion of individuals identified with early-stage liver cirrhosis [(14)]. Since most screening gastroscopies provide negative findings, non-invasive screening techniques for the diagnosis or exclusion of EV or HRV seem promise in reducing unnecessary gastroscopies [(15)]. Finding out, which Egyptian patients with liver cirrhosis and low HRV probability might safely forego upper endoscopy screening was the goal of this study.

Age and gender-related results from this study (P=0.371) agree with those of **Dabour *et al.*** [(16)], who found no statistically significant difference between gender and age (P>0.05). **Gomaa *et al.*** [(17)] looked at noninvasive indicators in the classification of risky and non-risky varices. They found that patients with large EVs had PLTs that were statistically significantly lower than those of patients with small EVs (68.5±8.6 ×109/L and 122.5±29.8 × 109/L respectively). These results go with the findings of our study, which showed that the PLT in the group without varices (118.8 ± 9.68 ×109/L) was significantly higher than in that of the groups with LRV (106.3±11.09 ×109/L) and HRV (74.5±10.61 ×109/L).

There were statistically significant variations in serum albumin, INR, total serum bilirubin, and direct serum bilirubin across the three groups in the current study. This is consistent with the observations made by **Alsebaey *et al.*** [(18)] who found that the variceal group had higher bilirubin levels (2.01 ± 2.16 mg/dl, 1.26 ± 1.74 mg/dl respectively) and longer INR (1.33 ± 0.28, 1.17 ± 0.28 respectively) than the non-variceal group. Total serum bilirubin, direct serum bilirubin, and INR were all increased significantly in the HRV group compared to the LRV and no varices groups. **Kim *et al.*** [(14)] and **Hong *et al.*** [(19)] also discovered that patients with EVs had longer INRs and higher bilirubin levels than patients without EVs. On contrary**, Kumar *et al.*** [(20)] analyzed the non-invasive markers of EV in cirrhosis and found no significant relationship (P >0.05) between large EV, bilirubin, and INR.

In the current investigation, patients with HRV had significantly lower serum albumin levels than those with LRV (P<0.002). This is in line with a research, which showed that EVs are linked to reduced serum albumin levels [(14, 17)]. But **Kumar *et al.*** [(20)]

found no evidence of a significant relationship between serum albumin and large EV.

Regarding WBCs, it was discovered that they were higher in no varices group (7.6 ± 1.96 × 10^9/L) than in HRV (5.1 ± 1.28 × 10^9/L) and LRV groups (6.5 ±1.72 × 10^9/L). Moreover, it was discovered that they were considerably greater in LRV (6.5 ± 1.72 × 10^9/L) as compared to HRV (5.1 ± 1.28 × 10^9/L). Similar results were obtained by **Alsebaey *et al.*** [18] who found that WBCs were statistically significantly higher in the non-variceal group (6.52 ± 7.16 × 10^9/L) than in the variceal group (4.60 ± 1.44 × 10^9/L, respectively).

The child score in our study exhibited a statistically significant higher values in HRV group compared to no varices and LRV groups. Supporting our results, **Dabour *et al.*** [16] studied the role of spleen and liver stiffness in grading and risk of bleeding of EV in cirrhotic individuals and found that higher child score values were linked significantly with EVs susceptibility in cirrhotic patients.

The assessment of liver stiffness showed statistically significant lower results in the group without varices than in the LRV group (24.9 ± 2.7 kpa and 29.4 ± 5.5 kpa, respectively), and in the LRV group (29.4 ± 5.5 kpa) than in the HRV group (38.6 ± 9.26 kpa). This is consistent with **El-Toukhy *et al.*** [21] findings, which showed that patients with EV had considerably greater liver stiffness measurements than patients without varices; at the cutoff (≥28 kpa), the test had 63.4% sensitivity and 100% specificity in EV prediction.

In this research, the stiffness of the spleen showed significant differences across groups: it was notably lower in the group without varices compared to those with LRV group (30.2 ± 3.3 kpa versus 41.6 ± 4.14 kpa, respectively). Additionally, spleen stiffness was significantly lower in the LRV group compared to the HRV group (41.6 ± 4.14 kpa versus 64.2 ± 11.44 kpa, respectively). These findings align with **Shawky *et al.*** [22], who observed that patients with small OV had a spleen stiffness of 65.95 ± 9.30 kpa, while those with medium and large OV had a stiffness of 70.55 ± 7.67 kpa, both significantly higher than patients without OV (41.93 ± 8.53 kpa). They suggested a cutoff value of 61.25 kpa with 86% sensitivity and 74.5% specificity for diagnosing varices. Similarly, **Sharma *et al.*** [23] found that spleen stiffness measurements above 40.8 kpa had a sensitivity of 94%, specificity of 76%, PPV of 91%, NPV of 84%, and diagnostic accuracy of 86% in predicting EV.

In our study, a multivariate regression analysis of our variables demonstrated that elevated LSM, increased SSM, higher INR, and decreased platelet count were the sole independent predictors of HRVs among individuals with liver cirrhosis. These findings echo those of **Ismail** [24] who revealed that patients with HRVs exhibited notably elevated bilirubin levels, INR, and LSM values, along with significantly lower PLTs and albumin levels compared to those without HRVs.

The ROC curve analysis indicated that an LSM value below 29.1 kpa can effectively rule out high-risk varices, showing an AUC of 0.886 along with 71.11% sensitivity, 95.38% specificity, 95.52% PPV, and 70.45% NPV. This aligns with the findings of **Dabour *et al.*** [16], who reported an LSM cut-off of 28.2 kpa for predicting EV, yielding an AUC of 0.905, sensitivity of 75%, specificity of 83.3%, PPV of 88.9%, NPV of 65.2%, and accuracy of 78%.

The analysis of the ROC curve demonstrated that setting the SSM threshold at less than 45 kpa was highly reliable for ruling out high-risk varices (AUC=0.983), with a sensitivity of 93.85%, specificity of 96.67%, PPV of 95.3%, and NPV of 95.6%. Our findings closely resemble those of the Baveno VII algorithm, which suggests an SSM threshold of less than 40 kpa. Consistent with our results, **Colecchia *et al.*** [25] found that an SSM threshold of ≤ 46 kpa was the most accurate in ruling out patients with HRV. We found that the SSM cut-off for EV prediction was 55.5 kpa, with an AUC of 0.970, sensitivity of 87.5%, specificity of 94.4%, PPV of 96.5%, NPV of 80.9%, and accuracy of 54%. These figures are less than those discovered by **Dabour *et al.*** [16].

Our results elucidated that a platelet count equal to or exceeding 93 demonstrates a significant capacity to effectively exclude high-risk varices, as evidenced by an AUC of 0.994, sensitivity of 88.89%, specificity of 96.92%, PPV of 97.56%, and NPV of 96.30%. These findings align with those of **Ismail** [24] whose study suggested that a platelet count surpassing 110 serves as a viable criterion for the exclusion of high-risk varices, yielding an AUC of 0.70.

Higher INRs and lower blood albumin levels can effectively rule out high-risk varices. Numerous studies have demonstrated that low blood albumin can predict both the existence of all OV and large OV alone. Low serum albumin levels are indicative of impaired hepatic function. According to **Duah *et al.*** [26], there is a possibility of a correlation between the degree of hepatic dysfunction and the onset of portal hypertension and varices.

CONCLUSIONS

The fibroscan-measured spleen and liver stiffness showed a rise corresponding to the severity of varices in cirrhotic patients. Spleen stiffness outperformed liver stiffness in its ability to exclude high-risk varices among individuals with liver cirrhosis. Specifically, spleen stiffness can predict the presence of high-risk varices at a threshold of ≥ 45 kpa. The application of the Baveno VII criteria has demonstrated precision in identifying varices necessitating treatment and pinpointing patients at an elevated risk of hepatic events.

Data Sharing Statement: All inf
ormation and resources used in this work are accessible.

Competing interest: No competing interests are disclosed by the authors of this paper.

Acknowledgements: Not relevant.

Funding: The authors had no disclosed funding source.

REFERENCES

1. **Devarbhavi H, Asrani S, Arab J *et al.* (2023):** Global burden of liver disease: 2023 update. Journal of Hepatology, 79 (2): 516–537.
2. **Kountouras J, Kazakos E, Kyrailidi F *et al.* (2023):** Innate immunity and nonalcoholic fatty liver disease. Annals of Gastroenterology, 36 (3): 244-48.
3. **Jakab S, Garcia-Tsao G (2019):** Screening and Surveillance of Varices in Patients with Cirrhosis. Clinical Gastroenterology and Hepatology, 17 (1): 26–29.
4. **El-Kassas M, Elakel W, Alboraie M *et al.* (2022):** Egyptian revalidation of non-invasive parameters for predicting esophageal varices in cirrhotic patients: A retrospective study. Arab Journal of Gastroenterology, 23 (2): 120–124.
5. **Mattos Â, Terra C, Farias A *et al.* (2021):** Primary prophylaxis of variceal bleeding in patients with cirrhosis: A comparison of different strategies. World Journal of Gastrointestinal Endoscopy, 13 (12): 628-32.
6. **Sharma M, Singh S, Desai V *et al.* (2019):** Comparison of Therapies for Primary Prevention of Esophageal Variceal Bleeding: A Systematic Review and Network Meta-analysis. Hepatology, 69 (4): 1657–1675.
7. **Wu C, Lui R, Wong V *et al.* (2023):** Baveno VII Criteria Is an Accurate Risk Stratification Tool to Predict High-Risk Varices Requiring Intervention and Hepatic Events in Patients with Advanced Hepatocellular Carcinoma. Cancers, 15 (9): 2480. doi: 10.3390/cancers15092480
8. **De Franchis R, Bosch J, Garcia-Tsao G *et al.* (2022):** Baveno VII – Renewing consensus in portal hypertension. Journal of Hepatology, 76 (4): 959–974.
9. **Pagliaro L, Spina G, D'Amico G *et al.* (1987):** Reliability of endoscopy in the assessment of variceal features. J Hepatol., 4 (1):93-8.
10. **Alqahtani S, Jang S (2021):** Pathophysiology and Management of Variceal Bleeding. Drugs, 81 (6): 647–667.
11. **Zhou H, Hu H, Tian M *et al.* (2020):** Validation and Refinement of the Baveno VI Criteria for Ruling Out High-Risk Varices. Gastroenterology Research and Practice, 20: 4217512. doi: 10.1155/2020/4217512.
12. **Garcia-Tsao G, Abraldes J, Berzigotti A *et al.* (2017):** Portal hypertensive bleeding in cirrhosis: Risk stratification, diagnosis, and management: 2016 practice guidance by the American Association for the study of liver diseases. Hepatology, 65 (1): 310–335.
13. **Dzeletovic I, Baron T (2012):** History of portal hypertension and endoscopic treatment of esophageal varices. Gastrointestinal Endoscopy, 75 (6): 1244–1249.
14. **Kim T, Jeong W, Sohn J *et al.* (2015):** Evaluation of portal hypertension by real-time shear wave elastography in cirrhotic patients. Liver International, 35 (11): 2416–2424.
15. **Pateu E, Oberti F, Calès P (2018):** The noninvasive diagnosis of esophageal varices and its application in clinical practice. Clinics and Research in Hepatology and Gastroenterology, 42 (1): 6–16.
16. **Dabour A, Abd El-Aty B, Abdelsameea E (2022**): Role of Liver and Spleen Stiffness in Predicting the Degree and Bleeding Risk of Esophageal Varices in Cirrhotic Patients. Benha Medical Journal, 39 (2): 383–396.
17. **Gomaa A, Mohammed S, Mousa W *et al.* (2018):** Evaluation of ALBI, MELD and Child-Pugh Scores as non-Invasive Predictors of Esophageal Varices. The Egyptian Journal of Hospital Medicine, 73 (8): 7358-7364.
18. **Alsebaey A, Elmazaly M, Abougabal H (2020):** Prediction of esophageal varices in patients with HCV-related cirrhosis using albumin-bilirubin, platelets-albumin-bilirubin score, albumin-bilirubin-platelets grade, and GAR. Egyptian Liver Journal, 10 (1): 1–8.
19. **Hong W, Dong L, Jiang Z *et al.* (2011):** Prediction of large esophageal varices in cirrhotic patients using classification and regression tree analysis. Clinics (Sao Paulo, Brazil), 66 (1): 119–124.
20. **Kumar P, Singh K, Joshi A *et al.* (2020):** Evaluation of non-invasive marker of esophageal varices in cirrhosis of liver. Journal of Family Medicine and Primary Care, 9 (2): 992-96.
21. **El-Toukhy N, El-Toukhy R, Elsayed S *et al.* (2020):** Assessment of Spleen Stiffness for Prediction of Varices in Patients with Hepatitis C Related Cirrhosis Using Transient Elastography. International Journal of Tropical Disease & Health, 2: 9–18.
22. **Shawky A, Abdel Aziz A, Alphonse C *et al.* (2019):** Evaluation of spleen stiffness compared to liver stiffness as non-invasive predictors for esophageal varices in patient with liver cirrhosis (Egyptian study). Gastroenterology, Hepatology and Endoscopy, 4 (4): 15761. DOI: 10.15761/GHE.1000192
23. **Sharma P, Kirnake V, Tyagi P *et al.* (2013):** Spleen stiffness in patients with cirrhosis in predicting esophageal varices. The American Journal of Gastroenterology, 108(7): 1101–1107.
24. **Ismail M (2023):** Prediction of High-Risk Varices in Patients with Compensated Advanced Chronic Liver Disease in Saudi Arabia. Clinical and Experimental Gastroenterology, 16: 117–127.
25. **Colecchia A, Ravaioli F, Marasco G *et al.* (2018):** A combined model based on spleen stiffness measurement and Baveno VI criteria to rule out high-risk varices in advanced chronic liver disease. Journal of Hepatology, 69 (2): 308–317.
26. **Duah A, Nkrumah K, Tachi K (2019):** Non-invasive markers as predictors of oesophageal varices in cirrhotic patient in a teaching hospital in Ghana. Ghana Med J., 53 (2): 142-149.