Original Article

Shear Wave Elastography as a Non-Invasive Predictor for the Presence and Severity of Oesophageal Varices in Chronic Liver Disease

Qazi Aamir Suhail[1], Shagufta Parveen[2], Showkat Ahmad Kadla[3], Nisar A Shah[4], Waseem Ramzan Dar[5], Shujat Gul[6], Waseem Javid[7]

[1]DNB Scholar, Department of Gastroenterology Government medical college, Srinagar, Jammu and Kashmir, India. [2] Associate Professor, Department of Pharmacology, GMC, Srinagar, Jammu and Kashmir, India,[3]Professor and Head, Department of Gastroenterology, GMC, Srinagar, Jammu and Kashmir, India. [4]Professor, Department of Gastroenterology, GMC, Srinagar, Jammu and Kashmir, India. [5]DNB Scholar, Department of Gastroenterology, GMC, Srinagar, Jammu and Kashmir, India. [6] Senior Resident, Department of Gastroenterology, GMC, Srinagar, Jammu and Kashmir, India

Abstract

Background: Chronic liver disease (CLD) is a major global health burden that often progresses to cirrhosis, portal hypertension and results its complications including esophageal varices (EV), which carry a high risk of morbidity and mortality. Upper gastrointestinal endoscopy remains the gold standard for diagnosing EV; however, it is invasive, costly, not easily available and sometimes poorly tolerated by patients. We aimed to evaluate the diagnostic accuracy of liver stiffness measurement (LSM) using shear wave elastography (SWE) as a non-invasive tool to predict the presence and severity of EV in patients with cirrhosis. **Material and Methods:** A total of 339 patients with compensated liver disease were included in this study. The patients underwent shear wave elastography to measure LSM along with endoscopic evaluation. Based on endoscopic findings, patients were divided into two groups: those with no varices (Group I) and those with varices (Group II), further subdivided into low risk (small varices) and high-risk (large varices or those with red color signs). **Results:** LSM was significantly higher in patients with EV than in those without EV. An LSM cut-off of 24.8 kPa predicted the presence of EV with 93.1% sensitivity and 87.3% specificity. For high-risk varices, an LSM cut-off of 33.6 kPa showed 94.7% sensitivity and 85.6% specificity. **Conclusion:** Shear wave elastography is an effective and non-invasive method for predicting EV in patients with cirrhosis. This approach may serve as an efficient alternative to endoscopy for optimizing patient management, and resource allocation.

Keywords: Shear wave elastography, esophageal varices, non-invasive screening, cirrhosis.

Received: 01 June 2025 **Revised: 04 July 2025** **Accepted: 19 August 2025** **Published: 17 September 2025**

Introduction

Chronic liver disease (CLD) is a major global health concern, contributing significantly to morbidity and mortality worldwide. Liver cirrhosis often marks the terminal stage of CLD.[1] Esophageal varices (EV), a common and serious complication, are present in up to 90% of patients with cirrhosis.[2] Variceal bleeding is a life threatening event that has an incidence of 5% in patients with small EV and up to 15% in those with large EV; mortality per bleeding episode is around 10–20%.[3] Most cirrhotic patients develop EV over their lifetime (5–15%/year), and the rate of progression from small to large varices is estimated to be 8% per year.[4]

To reduce the risk of variceal bleeding, screening endoscopy is routinely performed at the time of diagnosis of cirrhosis and periodically in patients with known EV. This facilitates timely prophylactic interventions, such as beta-blockers or endoscopic variceal ligation.[5] Although endoscopy is the gold standard for detecting EV, it is invasive and often uncomfortable for patients.[4] Consequently, there is a growing need for simple, reliable, and non-invasive methods to limit endoscopy to high-risk individuals.[6]

Non-invasive markers, including liver stiffness measurement (LSM), platelet count, spleen size, and the platelet count-to-spleen diameter ratio, are being increasingly explored as alternatives for assessing EV.[6] LSM relies on the velocity of low-frequency elastic waves within the liver to assess stiffness. Transient elastography, an innovative ultrasound-based technique, provides a non-invasive means of measuring liver stiffness and has demonstrated high sensitivity and specificity for detecting fibrosis, significant fibrosis, and cirrhosis.[7]

This present study was aimed to evaluate liver stiffness, measured using shear wave elastography (SWE), as a predictive tool for the presence of EV in patients with CLD.

Materials and Methods

This study included 339 patients with chronic liver disease (CLD) who visited the outpatient department or were admitted to

Address for correspondence: Dr. Nisar Ahmad Shah, Professor, Department of Gastroenterology, Government. Medical College, Srinagar, Jammu and Kashmir, India.
E-mail: nisarshah19@gmail.com

DOI:
10.21276/amit.2025.v12.i3.54

How to cite this article: Suhail QA, Kadla SA, Shah NA, Dar WR, Gul S, Javid W. Shear Wave Elastography as a Non-Invasive Predictor for the Presence and Severity of Esophageal Varices in Chronic Liver Disease. Acta Med Int. 2025;12(3):157-161.

the Department of Gastroenterology at the Government Medical College, Srinagar, between October 2022 and March 2024 [Table 1]. Of these, 63 patients had no oesophageal varices (Group I), while 276 had EV (Group II). Group II was further subdivided based on the size of the varices into low-risk varices (Group IIa) and high-risk varices (Group IIb). The classification was conducted according to the Japanese Research Society for Portal Hypertension guidelines: grade 1, small, non-tortuous varices; grade 2, tortuous varices occupying less than 50% of the oesophageal radius; and grade 3, large, tortuous varices.

Table 1: Gender and Age Distribution in Study Population

Gender Distribution		
		Count (Percentage)
Gender	Male	184 (54.28%)
	Female	155 (45.72%)
Age Distribution		
Age Group	35-45 years	28 (8.4%)
	46-55 years	119 (35.5%)
	56-65 years	132 (39.4%)
	66-75 years	56 (16.7%)
Mean Age: 56.27 ± 8.91		Median: 56.00 (range: 35 – 75)

Our study excluded patients under 18 years of age, those with Child-Pugh C disease, those with a history of previous endoscopic treatment for EV, and those diagnosed with hepatocellular carcinoma. Informed consent was obtained from all participants, and the study was approved by the institutional ethics committee.

All participants underwent upper gastrointestinal endoscopy and liver stiffness measurement. Endoscopic examination was performed using an Olympus LED series, while liver stiffness was assessed by two skilled nursing staff members using the ECHOSENS FIBROSCAN 630 expert, with the results expressed in kilopascals (kPa) based on the median of ten validated measurements. Investigations were conducted using the government's Ayushman scheme.

Results

This study included 339 patients with chronic liver disease (CLD), of which 184 were males (54.3%) and 155 females (45.7%), with a mean age of 56.3 ± 8.9 years. In this study, 63 patients (18.6%) had no oesophageal varices (Group I) and 276 (81.4%) had oesophageal varices (Group II). Group II was further divided into low-risk (IIa: Grade 1 and 2) and high-risk (IIb: Grade 3 or grade 2 with red colour signs) groups. A total of 226 patients had low-risk varices and 50 patients had high-risk varices. Figure-1 showing box and whisker plot according to grade of varices in study population.

The mean liver stiffness measurement (LSM) was significantly higher in patients with oesophageal varices compared to those without varices (33.26 ± 6.07 kPa vs. 20.33 ± 5.62 kPa, $P < 0.001$). Among those with high-risk varices, the mean LSM was 40.20 kPa, significantly higher than the 30.3 kPa observed in the low-risk varices group ($P < 0.001$).

Regarding aetiology, 247 patients (72.8%) were NASH-related, 41 (12.1%) were Hepatitis C related, 33 (9.7%) were Hepatitis B related, 9 (2.65) had autoimmune hepatitis, and 9 (2.65) had biliary cirrhosis [Table 2].

Table 2: Variceal Status Age and Etiology of CLD in Study Population

Variceal Status According to Age Distribution			
Age Group	**Varices Present (n=276)**	**Varices Absent (n=63)**	**p-value**
35-45 years	25 (07.37%)	03 (0.88%)	0.7510
46-55 years	96 (28.32%)	23 (6.78%)	
56-65 years	107 (31.56%)	25 (7.37%)	
66-75 years	46 (13.57%)	10 (2.95%)	
Etiology of CLD in Study Population			
Etiology	**Count**	**Percentage**	
NASH	247	72.86	
Hep C	41	12.09	
Hep B	33	9.73	
Autoimmune Hepatitis	9	2.65	
Biliary Cirrhosis	9	2.65	

The optimal LSM cut-off for predicting the presence of esophageal varices was 24.8 kPa, achieving a sensitivity of 93.1%, specificity of 87.3%, and an accuracy of 92%. To predict high-risk varices, an LSM cut-off of 33.6 kPa was identified, with a sensitivity of 94.7% and specificity of 85.6% (accuracy 87.6%). For predicting esophageal varices, LSM exhibited an area under the ROC curve (AUC) of 0.918, and for predicting high-risk varices, the AUROC was 0.954 [Table 3].

Table 3: Diagnostic Characteristics of Various Non-invasive Parameters for Predicting

Diagnostic Characteristics							
	Variable	**Cut-off**	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Accuracy (%)**
Esophageal Varices	LSM (kPa)	≥24.80	93.1	87.3	97.0	74.3	92.0

High Risk Esophageal Varices	LSM (kPa)	≥ 33.60	94.7	85.6	65.1	98.3	87.6

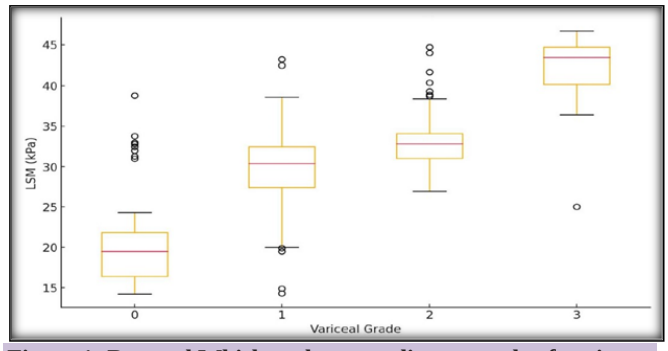

Figure 1: Box and Whisker plot according to grade of varices

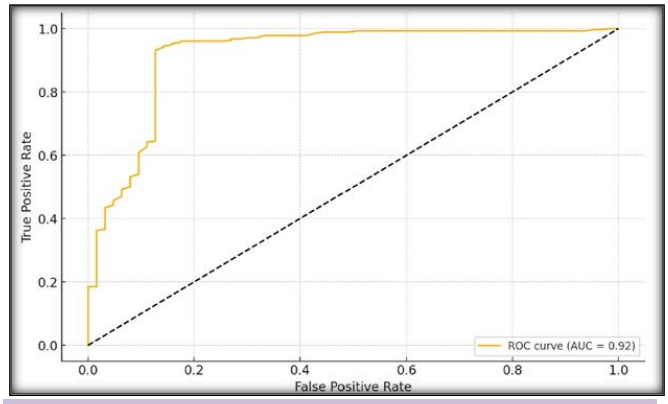

Figure 2: ROC curve of LSM values for predicting esophageal varices

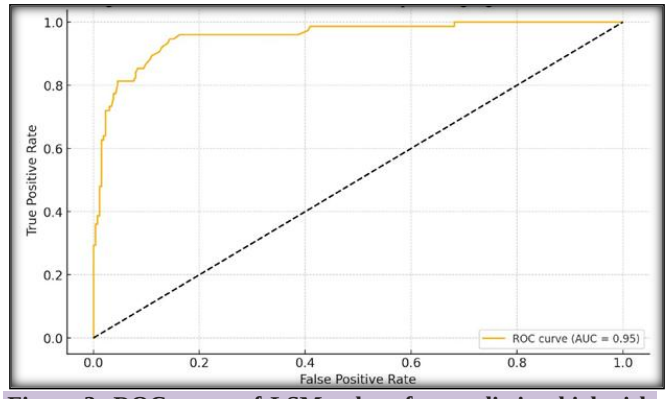

Figure 3: ROC curve of LSM values for predicting high risk varices

Discussion

Liver stiffness measurement (LSM) using non-invasive imaging techniques has emerged as a surrogate marker for assessing both portal hypertension and the risk of esophageal varices. Among these methods, transient elastography (TE) is the most extensively studied and has demonstrated accuracy in evaluating liver stiffness. However, its diagnostic performance can be limited in certain clinical settings, particularly in the presence of confounding factors such as significant ascites and obesity, which may interfere with TE ability to accurately reflect changes in liver parenchyma. Additionally, the effectiveness of TE depends on operator proficiency and technical expertise, which can pose challenges, especially in resource-limited facilities.

Shear Wave Elastography (SWE), another advanced ultrasound-based technique, offers real-time quantitative measurements of liver stiffness. By analyzing shear wave propagation, SWE provides a reliable and reproducible assessment of liver stiffness, overcoming many limitations associated with TE and enhancing diagnostic accuracy.

This study included 339 patients, with 54.28% being male and 45.72% female. The mean age of the cohort was 56.27 ± 8.91 years. No statistically significant differences were observed in the grade of esophageal varices (EV) based on sex or age distribution, suggesting that variceal development in cirrhosis is not strongly influenced by these demographic factors. The distribution of EV grades across different age groups also showed no significant correlation (p = 0.751).

Varices were present in 81.4% of patients: 36.3% had Grade 1, 30.7% had Grade 2, and 14.7% had Grade 3 varices. Grades 1 and 2 varices were classified as low-risk, while Grade 3 varices or Grade 2 varices with red color signs (RCS) were categorized as high-risk.

Liver stiffness measurement (LSM) effectively predicted EV in cirrhotic patients. An LSM cut-off of 24.8 kPa demonstrated a sensitivity of 93.1%, specificity of 87.3%, positive predictive value (PPV) of 97%, and overall diagnostic accuracy of 92%. For high-risk varices, an LSM cut-off of 33.6 kPa achieved a sensitivity of 94.7%, specificity of 85.6%, and accuracy of 87.6%, highlighting its value in risk stratification. Kazemi et al,[8] reported an LSM cut-off of 13.9 kPa with 95% sensitivity and 43% specificity for detecting EV, and a cut-off of 19 kPa for large varices with 91% sensitivity and 60% specificity. Vizzutti et al. identified 17.6 kPa as the optimal cut-off for EV prediction, with 90% sensitivity and 43% specificity.[9] Bureau et al,[10] found an LSM cut-off of 21 kPa could predict EV with 89.9% sensitivity and 93.2% specificity, although no correlation with variceal size was noted. Eric et al,[11] reported an LSM cut-off of 48 kPa for large EV, with 73.2% sensitivity and specificity. Pritchett et al,[12] suggested an LSM of >19.8 kPa as a cut-off for endoscopy and beta-blocker use, particularly in hepatitis C patients. Horia et al. predicted EV presence at a cut-off of 19 kPa with 84% sensitivity.[13] Stefanescu et al,[14] proposed 28 kPa as a threshold for EV prediction, with 74.3% sensitivity and 64.2% specificity. Sporea et al,[15] suggested a cut-off >29.5 kPa with 77.5% sensitivity, 86.9% specificity, and 78.9% accuracy for significant EV. Sharma et al. reported an LSM cut-off of 27.3 kPa, yielding 91% sensitivity and 72% specificity.[16] Yasmin et al. found a cut-off of 29 kPa with 95% sensitivity and 67% specificity for small EV, and 38 kPa with 100% sensitivity and 77.3% specificity for large EV.[17] Pár et al,[18] concluded that LSM by Fibro-Scan could predict EV with 85% sensitivity and 87% specificity at a cut-off of 19.2 kPa. Adriana et al. observed a cut-off of >15 kPa with 95.5% sensitivity and 100% specificity for EV prediction, and >28.8 kPa with 87.2% sensitivity and 82.76% specificity for large varices.[19] Bogdan et al. reported a cut-off of 21.1 kPa for predicting EV presence.[20]

These findings emphasize the robustness of LSM in predicting EV and high-risk varices, aligning with prior studies while

underscoring its utility as a non-invasive screening tool in cirrhotic patients. The receiver operating characteristic (ROC) curve analysis clearly highlights the exceptional diagnostic performance of LSM in predicting both esophageal varices and high-risk varices. For predicting esophageal varices, LSM exhibited an area under the ROC curve (AUC) of 0.918 and AUROC of 0.954 for high-risk varices, reflecting its excellent discriminative ability. Hu et al,[21] reported that a liver stiffness of more than 25.5 kPa could be utilized as a cut-off for predicting EV with 84.1% sensitivity, 72.5% specificity, PPV 71.7%, NPV 90.8%, and AUROC 85.5%. [Figure 2] shows ROC curve of LSM values for predicting esophageal varices. [Figure 3] shows ROC curve of LSM values for predicting high risk varices.

The limitation of our study was the inclusion of patients with different cirrhosis-related etiologies, as Fibro-Scan scores may differ depending on the etiology of the underlying liver cirrhosis. Our study also needs validation in larger cohorts and studies from multiple centers to assess the diagnostic role of Fibro-Scan alone and in combination with blood-based non-invasive tests in predicting varices and high-risk varices, which can avoid large numbers of screening Upper GI endoscopies in patients with compensated cirrhosis.

Conclusion

Liver stiffness measurement (LSM) plays a crucial role in stratifying the severity of oesophageal varices (EV), offering a more tailored approach to patient care. By accurately assessing liver stiffness, LSM allows clinicians to identify patients at varying levels of risk for developing or worsening varices. This capability supports timely and personalized interventions, such as earlier pharmacological treatments or endoscopic procedures, which can significantly reduce the risk of complications like variceal bleeding.

Moreover, LSM aids in the efficient allocation of healthcare resources. By identifying patients who require more intensive monitoring or interventions, it helps prioritize those at higher risk, while sparing low-risk individuals from unnecessary procedures. This targeted approach not only optimizes resource use but also contributes to a more cost-effective healthcare system. Ultimately, LSM's ability to guide personalized treatment decisions improves patient outcomes by preventing complications, reducing hospitalizations, and enhancing long-term liver health management.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Poynard T, Bedossa P, Opolon P. Natural history of liver fibrosis progression in patients with chronic hepatitis C. The OBSVIRC, METAVIR, CLINIVIR, and DOSVIRC groups. Lancet. 1997 Mar 22;349(9055):825-32. doi: 10.1016/s0140-6736(96)07642-8. PMID: 9121257.
2. J--ensen DM. Endoscopic screening for varices in cirrhosis: findings, implications, and outcomes. Gastroenterology. 2002 May;122(6):1620-30. doi: 10.1053/gast.2002.33419. PMID: 12016427.
3. Carbonell N, Pauwels A, Serfaty L, Olivier Fourdan O, Lévy VG, Poupon R. Improved survival after variceal bleeding in patients with cirrhosis over the past two decades. Hepatology 2004; 40:652–659.
4. Merli M, Nicolini G, Angeloni S, Rinaldi V, De Santis A, Merkel C, Attili AF, Riggio O. Incidence and natural history of small esophageal varices in cirrhotic patients. J Hepatol. 2003 Mar;38(3):266-72. doi: 10.1016/s0168-8278(02)00420-8. PMID: 12586291.
5. Bosch J, Berzigotti A, Garcia-Pagan JC, Abraldes JG. The management of portal hypertension: rational basis, available treatments and future options. J Hepatol. 2008;48 Suppl 1:S68-92. doi: 10.1016/j.jhep.2008.01.021. Epub 2008 Feb 12. PMID: 18304681.
6. Sandrin L, Fourquet B, Hasquenoph JM, Yon S, Fournier C, Mal F, Christidis C, Ziol M, Poulet B, Kazemi F, Beaugrand M, Palau R. Transient elastography: a new noninvasive method for assessment of hepatic fibrosis. Ultrasound Med Biol. 2003 Dec;29(12):1705-13. doi: 10.1016/j.ultrasmedbio.2003.07.001. PMID: 14698338.
7. Tsochatzis EA, Gurusamy KS, Ntaoula S, Cholongitas E, Davidson BR, Burroughs AK. Elastography for the diagnosis of severity of fibrosis in chronic liver disease: a meta-analysis of diagnostic accuracy. J Hepatol. 2011 Apr;54(4):650-9. doi: 10.1016/j.jhep.2010.07.033. Epub 2010 Sep 24. PMID: 21146892.
8. Kazemi F, Kettaneh A, N'kontchou G, Pinto E, Ganne-Carrie N, Trinchet JC, Beaugrand M. Liver stiffness measurement selects patients with cirrhosis at risk of bearing large oesophageal varices. J Hepatol. 2006 Aug;45(2):230-5. doi: 10.1016/j.jhep.2006.04.006. Epub 2006 May 16. PMID: 16797100.
9. Vizzutti F, Arena U, Romanelli RG, Rega L, Foschi M, Colagrande S, Petrarca A, Moscarella S, Belli G, Zignego AL, Marra F, Laffi G, Pinzani M. Liver stiffness measurement predicts severe portal hypertension in patients with HCV-related cirrhosis. Hepatology. 2007 May;45(5):1290-7. doi: 10.1002/hep.21665. PMID: 17464971.
10. Bureau C, Metivier S, Peron JM, Selves J, Robic MA, Gourraud PA, Rouquet O, Dupuis E, Alric L, Vinel JP. Transient elastography accurately predicts presence of significant portal hypertension in patients with chronic liver disease. Aliment PharmacolTher. 2008 Jun;27(12):1261-8. doi: 10.1111/j.1365-2036.2008.03701.x. Epub 2008 Apr 4. PMID: 18397389.
11. Eric NK, Pierre SL, Blaise T, Hugues C, Dominique C, Dupas JL. Non-invasive diagnosis of large oesophageal varices by fibroscan: strong influence of the cirrhosis etiology. Alcohol Clin Exp Res 2010; 34:1146–1153.
12. Pritchett S, Cardenas A, Manning D, Curry M, Afdhal NH. The optimal cut off for predicting large oesophageal varices using transient elastography is disease specific. J Viral Hepat 2011; 18:75–80.
13. Horia S, Mircea G, Monica L, Anca M, Dana C, Bogdan P, et al. A new and simple algorithm for the noninvasive assessment of esophageal varices in cirrhotic patients using serum fibrosis markers and transient elastography. J Gastroentestin Liver Dis 2011; 1:57–64.
14. Stefanescu H, Grigorescu M, Lupsor M, Procopet B, Maniu A, Badea R. Spleen stiffness measurement using fibroscan for the non-invasive assessment of esophageal varices in liver cirrhosis patients. J Gastroenterol Hepatol 2011; 26:164–170.
15. Sporea I, Rațiu I, Bota S, Șirli R, Jurchiș A. Are different cut off values of liver stiffness assessed by transient elastography according to the etiology of liver cirrhosis for predicting significant esophageal varices?. Med Ultrason 2013; 15:111–115.

16. Sharma P, Kirnake V, Tyagi P, Bansal N, Singla V, Kumar A. Spleens stiffness in patients with cirrhosis in predicting esophageal varices. Am J Gastroenterol 2013; 108:1101–1107.
17. Yasmin S, Mohamad S, Mohamad O, Ayman R, Zakaria S. Liver stiffness measurement by fibroscan predict the presence and size of oesophageal varices in Egyptian patients with HCV related liver cirrhosis. J Clin Diagn Res 2013; 7:2253–2257.
18. Pár G, Trosits A, Pakodi F, Szabó I, Czimmer J, Illés A, et al. Liver stiffness measurement selects patients with chronic liver diseases at risk of bearing large oesophageal varices. Z Gastroenterol 2013;51(05):A52.
19. Adriana B, Romeo I, Vasile V, Georgiana A, Maria R, Monica L. Value of hepatic elastography and Doppler indexes for predictions of esophageal varices in liver cirrhosis. Med Ultrason 2015; 17:5–11.
20. Bogdan P, Vasile M, Marie A, Mircea G, Paul S, Sophie M. Serum tests, liver stiffness and artificial neural networks for diagnosing cirrhosis and portal hypertension. Dig Liver Dis 2015; 47:411–416.
21. Hu Z, Li Y, Li C, Huang C, Ou Z, Guo J. Using ultrasonic transient elastography (fibroscan) to predict esophageal varices in patients with viral liver cirrhosis. Ultrasound Med Biol 2015; 41:1530–1537.