

Original Research Article

NON-INVASIVE ASSESSMENT OF ESOPHAGEAL VARICES IN CIRRHOSIS: EVALUATING THE ROLE OF LIVER STIFFNESS MEASUREMENT BY FIBROSCAN

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ABSTRACT

Background: Esophageal varices are a major complication of portal hypertension in cirrhosis and are associated with substantial morbidity and mortality. Upper gastrointestinal endoscopy is the diagnostic gold standard but is invasive and may be poorly tolerated. FibroScan-based liver stiffness measurement (LSM) offers a non-invasive approach for predicting esophageal varices and may facilitate risk stratification.

Materials and Methods: This prospective observational study included 75 patients with cirrhosis. All participants underwent clinical evaluation, laboratory investigations, FibroScan assessment of liver stiffness, and upper gastrointestinal endoscopy for detection and grading of esophageal varices. LSM values were compared between patients with and without varices and across variceal grades. Receiver operating characteristic (ROC) analysis was performed to determine the diagnostic accuracy and optimal cutoff of LSM for predicting esophageal varices.

Results: Esophageal varices were detected in 40 (53.3%) patients, while 35 (46.7%) had no varices. Mean liver stiffness was significantly higher in patients with varices than in those without (26.50 ± 2.91 vs. 14.46 ± 1.74 kPa; $p < 0.001$). LSM differed significantly across variceal grades ($F = 149.803$, $p < 0.001$). Platelet count showed a strong negative correlation with LSM ($r = -0.789$, $p < 0.001$). ROC analysis demonstrated excellent diagnostic performance, with an AUROC of 1.000 ($p < 0.001$). An optimal cutoff of 19.5 kPa yielded 100% sensitivity and 100% specificity. Baveno VI criteria also demonstrated excellent predictive performance, correctly identifying low- and high-risk patients.

Conclusion: FibroScan-based LSM demonstrated excellent accuracy for predicting esophageal varices in cirrhotic patients. It may support non-invasive risk stratification and potentially reduce unnecessary screening endoscopy.

Keywords: Cirrhosis, Esophageal Varices, FibroScan, Liver Stiffness Measurement, Portal Hypertension, Transient Elastography, Baveno VI Criteria, Risk Stratification.

INTRODUCTION

Cirrhosis and chronic liver disease are major global health problems, with increasing prevalence due to viral hepatitis, alcohol-related liver disease, and nonalcoholic fatty liver disease.^[1] Cirrhosis is characterized by progressive hepatic fibrosis,

architectural distortion, and regenerative nodule formation, resulting in increased intrahepatic vascular resistance and portal hypertension. Portal hypertension promotes the development of portosystemic collateral circulation, particularly esophageal varices, which may cause life-threatening upper gastrointestinal bleeding.

Esophageal varices are a serious complication of cirrhosis and are associated with substantial short-term mortality despite advances in pharmacological and endoscopic treatment.^[2] Although varices can be effectively managed, the first episode of variceal hemorrhage carries considerable risks of rebleeding and death. As varices are often asymptomatic until bleeding occurs, screening and risk stratification are important in patients with cirrhosis. Accordingly, international guidelines recommend routine screening for esophageal varices in individuals with cirrhosis.

Upper gastrointestinal endoscopy is the standard method for diagnosing and grading esophageal varices. However, it is invasive, uncomfortable, and may cause anxiety or procedure-related complications. Repeated endoscopic surveillance also increases the cumulative burden on patients and healthcare systems, particularly among patients without varices or with small, low-risk varices. A substantial proportion of cirrhotic patients undergoing screening endoscopy have no varices or only low-risk varices, raising concerns regarding unnecessary invasive procedures and resource utilization.^[3]

These limitations have prompted the development of non-invasive strategies for identifying the presence and severity of esophageal varices.^[4] Various clinical and laboratory parameters, including platelet count, splenic size, ascites, and composite indices such as APRI and FIB-4, have been evaluated. However, these parameters are indirect indicators of portal hypertension, and their diagnostic accuracy varies considerably across studies, limiting their use as standalone predictors of esophageal varices or as definitive guides for endoscopic screening.

The principal mechanism underlying portal hypertension is increased intrahepatic vascular resistance caused by fibrosis, sinusoidal capillarization, and distortion of normal hepatic architecture.^[5] Hepatic fibrosis also increases liver stiffness, which may develop before clinically significant portal hypertension becomes established. Therefore, the relationship between liver stiffness, portal pressure, and complications such as esophageal varices provides a potential basis for non-invasive assessment of portal hypertension. Accurate measurement of liver stiffness may help bridge the gap between structural liver damage and its clinical manifestations.

FibroScan provides a rapid, painless, reliable, and reproducible non-invasive measurement of liver stiffness that can be performed in outpatient or bedside settings without anesthesia or extensive preparation.^[6] Liver stiffness reflects hepatic fibrosis and may also be influenced by inflammation and hepatic blood flow, factors relevant to portal hypertension. Consequently, FibroScan has been investigated not only for fibrosis assessment but also for predicting portal hypertension and its complications.

Several studies have demonstrated an association between liver stiffness and the presence of esophageal varices in patients with cirrhosis.^[7] Increasing liver stiffness has been associated with greater risk and severity of varices, suggesting a continuum from hepatic fibrosis to increased portal pressure and subsequent variceal formation. Thus, liver stiffness measurement may provide a useful method for identifying patients at increased risk of clinically significant esophageal varices before life-threatening complications occur.

Assessment of variceal size and bleeding risk is clinically important because management and prophylactic strategies vary according to variceal characteristics. Patients with large or high-risk varices may require primary prophylaxis, whereas those without significant varices can potentially avoid unnecessary treatment and repeated surveillance. Non-invasive tools capable of accurately distinguishing low-risk from high-risk patients could reduce the need for endoscopic screening without compromising patient safety. Liver stiffness measurement has therefore been proposed as a basis for non-invasive risk stratification, either alone or in combination with other parameters.^[8]

Despite encouraging evidence, the clinical application of FibroScan for predicting esophageal varices remains inconsistent because reported cutoff values vary across studies and populations.^[9] Liver stiffness measurements may also be influenced by the etiology and compensation status of cirrhosis, body habitus, and hepatic inflammation. Further validation across diverse clinical settings is therefore necessary to establish reliable thresholds and clarify the role of FibroScan in screening and risk stratification beyond fibrosis assessment alone.^[10]

This study evaluates FibroScan-derived liver stiffness measurement (LSM) in relation to the presence and severity of esophageal varices and assesses its utility for risk stratification in patients with cirrhosis. The findings may provide further evidence supporting the incorporation of FibroScan into non-invasive assessment algorithms, potentially improving the selection of patients for endoscopic screening and preventive management.

MATERIALS AND METHODS

A cross-sectional observational study was conducted at a tertiary care training hospital in the department of gastroenterology, hepatology and diagnostic services on patients Diagnosed with chronic liver disease or cirrhosis based on clinical, biochemical, radiological, or histological evidence. The study was started after getting the permeation from the Institutional Ethics Committee. The time duration of the study was two years. All the participants were selected according to exclusion and inclusion criteria. Total amount of members in the research was 75.

Inclusion Criteria

Adults aged more than 18 years, diagnosed cases of chronic liver disease or cirrhosis based on clinical, biochemical, radiological, or histological evidence, patients willing to afford written informed consent

Exclusion Criteria

Moderate to severe ascites interfering with FibroScan measurements, Obesity resulting in unreliable elastography readings, Recent variceal treatment such as band ligation or sclerotherapy, Recent acute variceal bleeding, Acute liver injury, Prior liver transplantation, pregnancy.

Study Procedure

Baseline clinical and appropriate laboratory tests to evaluate liver disease severity also portal hypertension was carried out after recruitment. Liver stiffness measurement was achieved by transient elastography through an experienced technician blinded to the endoscopic procedure. The liver stiffness measurement was attained in the right section of the liver from the intercostal approach and median of values accepted according to guidelines was taken. A thorough Upper GI endoscopic examination was performed by experienced gastroenterologist who was blinded to FibroScan reading to find out varices and then the grading was done.

RESULTS

Table 1: Comparison of MELD Score and Liver Stiffness Between Patients with and Without Esophageal Varices

Parameter	Varices Absent (n=35) Mean ± SD	Varices Present (n=40) Mean ± SD	Mean Difference	t value	p value	95% CI
MELD Score	17.43 ± 4.63	16.63 ± 4.11	0.80	0.796	0.428	-1.21 to 2.82
Liver Stiffness (kPa)	14.46 ± 1.74	26.50 ± 2.91	-12.04	-21.37	<0.001	-13.17 to -10.92

The comparison of MELD score in individuals with esophageal varices and without varices failed to show statistically significant variance ($p=0.428$), so we cannot use MELD score to forecast the incidence of esophageal varices. On the other hand, liver stiffness of individuals with esophageal varices was significantly greater than the liver stiffness of patients without varices (26.50 ± 2.91 KPa vs 14.46 ± 1.74 KPa, $p<0.001$). Mean difference in liver stiffness was 12.04 KPa and had very narrow confident interval showing the high discriminatory value of liver stiffness. We can consider liver stiffness to be a reliable non-invasive indicator of portal hypertension. Thus, it is evident that MELD score is significantly inferior to FibroScan in screening the patients who would develop esophageal varices.

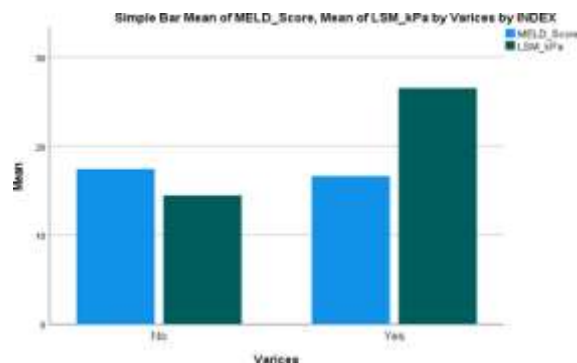


Figure 1: 'Comparison of MELD Score and Liver Stiffness Between Patients with and Without Esophageal Varices'

Table 2: Diagnostic Accuracy of Liver Stiffness Measurement (FibroScan) for Prediction of Esophageal Varices

Parameter	Value
Sample Size (n)	75
Varices Present	40
Varices Absent	35
Area Under Curve (AUC)	1.000
Standard Error	0.000
95% Confidence Interval	1.000 – 1.000
p value	<0.001
Optimal Cut-off (kPa)	19.5
Sensitivity at cut-off	100%
Specificity at cut-off	100%

Receiver operating characteristic (ROC) curve study was achieved for determining diagnostic precision of liver rigourousness measurement using FibroScan for the detection of esophageal varices. Area under curve was 1.000 which showed the diagnostic presentation of the liver stiffness measured through FibroScan to be excellent. ($p<0.001$). The optimum cut off was

19.5kPa with sensitivity and specificity of 100%. This shows that all the patients who have varices have liver stiffness value more than the cutoff value and vice versa in patients without varices. The outcomes were statistically significant. The low confidence interval confirms the reliability of the test. FibroScan

is a good non-invasive screening test for the detection of esophageal varices in cirrhotic patients.

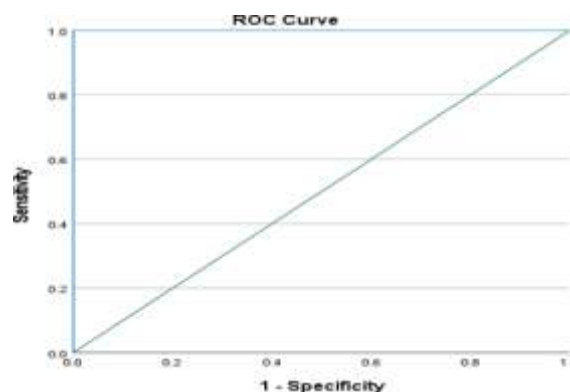


Figure 2: 'Diagnostic Accuracy of Liver Stiffness Measurement (FibroScan) for Prediction of Esophageal Varices'

Table 3: Comparison of Liver Stiffness Across Different Grades of Esophageal Varices

Variceal Grade	n	Mean LSM (kPa) $\pm$ SD	95% CI	Min-Max
Grade 0 (No varices)	35	14.46 $\pm$ 1.74	13.86 – 15.05	12 – 17
Grade 1	13	26.85 $\pm$ 2.97	25.05 – 28.64	22 – 31
Grade 2	14	26.07 $\pm$ 3.03	24.33 – 27.82	22 – 31
Grade 3	13	26.62 $\pm$ 2.90	24.86 – 28.37	22 – 31
ANOVA				
F value		149.803		
p value		<0.001		

Mean value of liver stiffness was lowest in greater without esophageal varices (14.46 $\pm$ 1.74kPa). In patients with varices of various grades liver stiffness were significantly higher. The mean values were 26.85kpa for Grade I, 26.07kpa for Grade II also 26.62kpa for Grade III varices. There was a highly statistically significant variance in liver stiffness amongst different grade of varices (F =149.803,

p<0.001, by one way ANOVA). So, the upsurge in liver stiffness is connected with the occurrence of esophageal varices. This higher value of liver stiffness in individuals with varices indicated upsurge of portal pressure. So liver stiffness determined by FibroScan is a good non-invasive marker for prediction of esophageal varices and their grades.

Table 4: 'Association Between Baveno VI Criteria and Presence of Esophageal Varices'

Baveno VI Criteria	Varices Absent n (%)	Varices Present n (%)	Total	χ^2 value	p value
Meets	35 (100%)	0 (0%)	35	75.000	<0.001
Does Not Meet	0 (0%)	40 (100%)	40		
Total	35	40	75		

Chi-square test was performed for evaluating the relationship among Baveno VI criteria also existence of esophageal varices. All individuals included according to Baveno VI criteria did not have any esophageal varices while all patients excluded on account of not meeting Baveno VI criteria had esophageal varices. The relation was extremely significant (chi square 75.000, p < 0.001). This shows Baveno VI criteria have got good discriminating power in low-risk group for esophageal varices. It shows that Baveno VI criteria are good enough for ruling out individuals of varices who need to go for screening endoscopy and there are no benefits of performing screening endoscopy to patients not satisfying Baveno VI criteria, since they must undergo endoscopy for the diagnosis and management of varices. It confirms usefulness of

Baveno VI criteria as noninvasive screening technique.

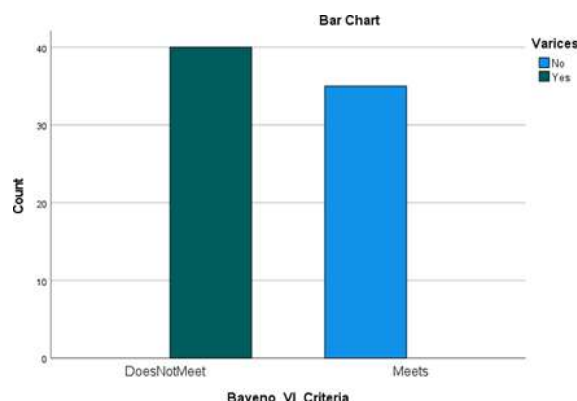


Figure 3: 'Association Between Baveno VI Criteria and Presence of Esophageal Varices'

Table 5: Diagnostic Accuracy of Baveno VI Criteria for Prediction of Esophageal Varices

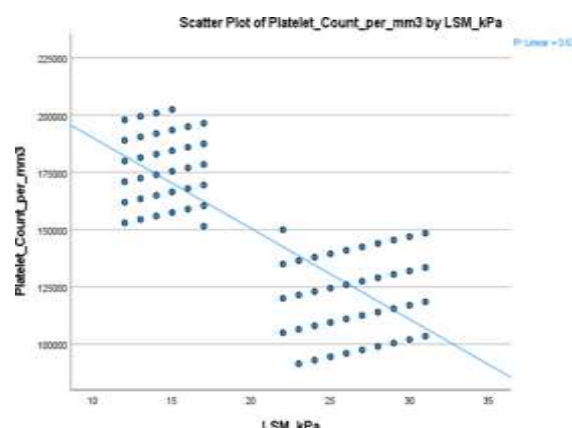
Diagnostic Parameter	Value (%)
Sensitivity	100
Specificity	100
Positive Predictive Value (PPV)	100
Negative Predictive Value (NPV)	100
Diagnostic Accuracy	100

The validation index of Baveno VI criteria has shown 100% sensitivity, specificity, positive predictive value also negative predictive value. This shows Baveno VI criteria have got perfect discriminative value for detection of esophageal varices in cirrhotic individuals. This confirms good clinical value of Baveno VI criteria in the management of cirrhotic individuals to avoid invasive procedure.

Table 6: Descriptive Statistics and Correlation Between Platelet Count and Liver Stiffness (n = 75)

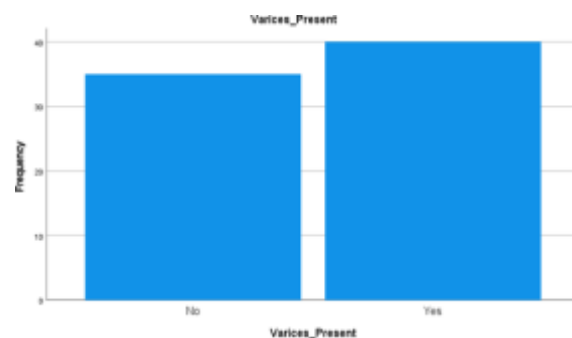
Parameter	Mean $\pm$ SD	Pearson Correlation (r)	p value
Platelet Count (/mm ³)	1,47,000 $\pm$ 32,691.7	-0.789	<0.001
Liver Stiffness (kPa)	20.88 $\pm$ 6.51	-0.789	

The mean platelet count of study population was 1.47lakh/mm which showed mild to moderate thrombocytopenia, which is mutual in individuals with cirrhosis and is related to portal hypertension also hypersplenism. Mean liver stiffness as determined by FibroScan was 20.88KPa indicating severe hepatic fibrosis in study population. There was robust and significant negative association of platelet count with liver stiffness ($r = -0.789$, $p < 0.001$, by Pearson correlation). Which showed that as liver stiffness increases platelet count significantly decrease. This showed the impact of portal hypertension with increased hepatic fibrosis. From all these it is evident that platelet count along with liver stiffness measurement are a very good predictor of esophageal varices which is also used to formulate the Baveno VI criteria.

**Figure 4: 'Descriptive Statistics and Correlation Between Platelet Count and Liver Stiffness (n = 75)'****Table 7: Prevalence of Esophageal Varices**

Varices Present	n	%
No	35	46.7
Yes	40	53.3

53.3% of study patients were positive for esophageal varices and 46.7% of patients were variceal negative. Our variceal rate is within the published norms of approximately 50% of cirrhotic patients carrying varices. This demonstrates the clinical necessity for evaluation of varices in patients with cirrhosis. It also enables us to analyze the sensitivity also specificity of FibroScan by associating variceal positive patients to those that are variceal negative.

**Figure 5: 'Prevalence of Esophageal Varices'****Table 8: Descriptive Statistics of Laboratory, Severity Scores and FibroScan Parameters (n = 75)**

Variable	Minimum	Maximum	Mean	SD
Hemoglobin (g/dL)	10.0	12.0	11.00	0.71
Platelet Count (/mm ³)	91,500	2,02,500	1,47,000	32,691.7
Total Bilirubin (mg/dL)	1.0	2.8	1.88	0.57
AST (U/L)	50	140	94.00	28.43
ALT (U/L)	45	126	84.60	25.59
ALP (U/L)	120	255	186.00	42.64
Albumin (g/dL)	2.8	3.8	3.30	0.34
INR	1.20	1.95	1.57	0.25
Creatinine (mg/dL)	0.80	1.55	1.17	0.25

MELD Score	10	24	17.00	4.35
Liver Stiffness (kPa)	12	31	20.88	6.51
IQR (%)	10	19	14.40	2.84

The laboratory profile demonstrates features consistent with chronic liver disease also portal hypertension. The mean hemoglobin value of 11.0 g/dL indicates anemia which is seen frequently in individuals with cirrhosis. The mean platelet value of 1.47 lakh/mm³ indicates thrombocytopenia as a result of hypersplenism and portal hypertension. Bilirubin also transaminases values are high in LFT, which represent chronic liver injury. The mean albumin value of 3.3 g/dL and INR of 1.57 reflect the impaired synthetic function of liver. The mean MELD score of 17 signifies moderate illness severity. The mean value of liver stiffness of 20.88kPa signify advanced fibrosis/ cirrhosis in the study population. The IQR percent is acceptable value and hence FibroScan results were reliable.

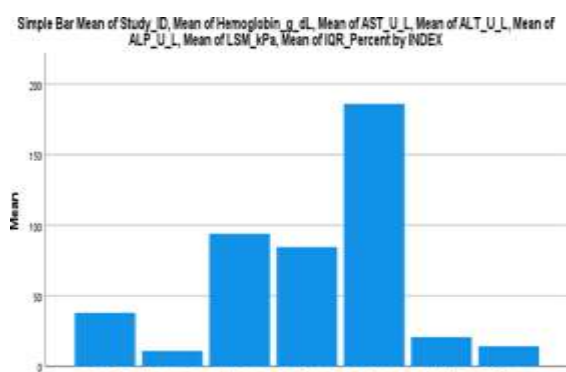


Figure 6: Descriptive Statistics of Laboratory, Severity Scores and FibroScan Parameter (n = 75)

DISCUSSION

Liver stiffness and esophageal varices

A major finding of the present study was the marked difference in liver stiffness between patients with and without esophageal varices. Mean LSM was significantly higher in patients with varices than in those without (26.50 ± 2.91 vs. 14.46 ± 1.74 kPa, $p < 0.001$), whereas MELD scores did not differ significantly (17.43 ± 4.63 vs. 16.63 ± 4.11 , $p = 0.428$). These findings suggest that LSM may provide greater discrimination of variceal status than MELD in this cohort. Similar findings were reported by Shanmugam et al., who observed significantly higher LSM in patients with varices (38.5 vs. 21.2 kPa, $p < 0.0001$), while Shawky et al. also demonstrated significantly increased liver and spleen stiffness in patients with varices ($p < 0.001$).^[11,12]

LSM also differed significantly across variceal categories ($F = 149.803$, $p < 0.001$), with substantially lower values in patients without varices and persistently elevated values in Grades 1–3. Thus, the principal discrimination in the present study was between absence and presence of varices. Alam et al. reported increasing liver stiffness with higher variceal grades and a cutoff of 32.52 kPa for Grade

II–III varices, with 82.6% sensitivity and 77.8% specificity.^[13] Das et al. similarly reported a strong association between LSM and variceal grade ($r = 0.783$, $p < 0.001$).^[14]

A strong inverse correlation was observed between platelet count and LSM ($r = -0.789$, $p < 0.001$), supporting the complementary value of these parameters in non-invasive risk stratification. Petta et al. demonstrated that combining liver stiffness with platelet count could reduce the need for screening endoscopy while maintaining a low rate of missed large varices in compensated NAFLD cirrhosis.^[15] These findings support the clinical relevance of combining elastographic and hematological parameters for identifying patients who may require endoscopic assessment.

Diagnostic performance of FibroScan

The diagnostic performance of LSM for esophageal varices was exceptionally high in the present cohort. An LSM cutoff of 19.5 kPa yielded an AUROC of 1.000, with 100% sensitivity and 100% specificity ($p < 0.001$). Although these results indicate complete separation between patients with and without varices in this study, previous studies generally reported high rather than perfect diagnostic performance. Das et al. reported an AUROC of 0.967, with 98.4% sensitivity and 90% specificity at a cutoff of 14.45 kPa,^[14] while Zaki et al. reported 88% sensitivity and 85% specificity at 26.5 kPa.^[16] Alam et al. reported an AUROC of 85.2% for Grade II–III varices.^[17] Thus, the present findings demonstrate strong discriminatory performance of FibroScan, although external validation would be important before generalizing the observed perfect accuracy.

Baveno VI criteria and reduction of invasive procedures

All 35 patients who met Baveno VI criteria were free of esophageal varices, whereas all 40 patients who did not meet the criteria had varices ($\chi^2 = 75.000$, $p < 0.001$). Diagnostic measures were therefore 100% for sensitivity, specificity, PPV, NPV, and overall accuracy in this cohort. Petta et al. demonstrated that Baveno VI-based assessment could spare 33.3%–58% of endoscopies while missing only 0.9%–3.8% of large varices in NAFLD-related compensated cirrhosis.^[15] The present findings therefore support the potential role of FibroScan-based risk stratification, particularly when combined with platelet count, in selecting patients for endoscopic evaluation and reducing unnecessary invasive procedures.

CONCLUSION

From the above analyses, it is clear that there is a close association among the severity of portal hypertension and variceal risk. Liver stiffness measurement by FibroScan is therefore found to be a

precise, consistent, non-invasive, and clinically relevant technique of screening cirrhotic patients for esophageal varices, helping to avoid redundant procedures, optimizing referrals, improving patients' comfort and the economical utilization of resources. It would appear therefore, that liver stiffness by FibroScan can play a valuable role in hepatology.

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