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Spleen Stiffness by Shear Wave Elastography as a Noninvasive Biomarker for Predicting Esophageal Varices in Chronic Liver Disease

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Abstract

Objective:

To evaluate the diagnostic performance of spleen stiffness measurement (SSM) using shear wave elastography (SWE) for predicting esophageal varices and assessing portal hypertension in patients with chronic liver disease (CLD).

Materials and Methods:

This prospective cross-sectional study included 70 patients with clinically and/or biochemically confirmed CLD. Patients were stratified based on the presence of esophageal varices. All subjects underwent grayscale ultrasonography followed by SWE using a LOGIQ E10 system with a C1–6-D convex transducer. Spleen stiffness was measured via an intercostal approach under breath-hold conditions, ensuring appropriate region-of-interest placement. Additional parameters, including spleen size, portal vein diameter, and biochemical indices (AST, ALT, and serum albumin), were recorded. Diagnostic performance was assessed using receiver operating characteristic (ROC) curve analysis.

Results:

Spleen stiffness values were significantly higher in patients with esophageal varices compared to those without (33.65 ± 3.09 kPa vs. 25.16 ± 1.79 kPa; $p < 0.001$). SWE demonstrated excellent diagnostic performance, with an area under the ROC curve (AUC) of 1.00. A cutoff value of >29.31 kPa yielded 100% sensitivity and specificity for detecting esophageal varices. Additionally, spleen stiffness showed a significant reduction following therapeutic intervention (29.40 ± 4.95 kPa to 26.75 ± 4.41 kPa; $p < 0.001$). SSM outperformed conventional sonographic and biochemical parameters in diagnostic accuracy.

Conclusion:

Spleen stiffness measurement using SWE is a reliable, reproducible, and non-invasive imaging biomarker for assessing portal hypertension and predicting esophageal varices. Its incorporation into routine ultrasound evaluation may facilitate non-invasive risk stratification and reduce reliance on invasive procedures such as endoscopy.

Keywords: NIL

Introduction

Portal hypertension is a major complication of chronic liver disease (CLD) and is associated with the development of esophageal varices, which carry a significant risk of morbidity and mortality. The current

reference standards for evaluating portal hypertension include hepatic venous pressure gradient (HVPG) measurement and upper gastrointestinal endoscopy. However, these techniques are invasive, expensive, and unsuitable for routine screening and follow-up.

Ultrasound-based elastography has emerged as a non-invasive modality for assessing tissue stiffness, reflecting underlying pathological and hemodynamic changes. While liver stiffness measurement has been extensively studied, spleen stiffness measurement (SSM) may provide a more direct surrogate marker of portal hypertension due to the spleen's anatomical and vascular continuity with the portal venous system.

Recent advances in shear wave elastography (SWE) allow quantitative and reproducible assessment of splenic stiffness. Several studies have suggested that increased spleen stiffness correlates with portal hypertension and the presence of esophageal varices.

Therefore, this study aimed to evaluate the diagnostic performance of spleen stiffness measured by SWE in predicting esophageal varices and assessing portal hypertension in patients with CLD.

Materials And Methods

Study Design And Population

This prospective cross-sectional study was conducted over a period of 20 months at a tertiary care center. A total of 70 patients with clinically and/or biochemically confirmed chronic liver disease were included.

Patients were divided into two groups:

- Group 1: CLD with esophageal varices
- Group 2: CLD without esophageal varices

Inclusion Criteria

- Age 18–70 years
- Diagnosed chronic liver disease
- Willing to participate

Exclusion Criteria

- Non-cirrhotic portal hypertension
- Hepatocellular carcinoma or extrahepatic malignancy
- Prior splenic intervention
- Pregnancy
- Poor acoustic window or non-compliance

Ultrasound And Elastography Protocol

All examinations were performed using a LOGIQ E10 ultrasound system with a C1–6-D convex transducer.

Grayscale ultrasonography was performed to assess:

- Spleen size
- Liver morphology
- Portal vein diameter

Spleen stiffness was measured using shear wave elastography via an intercostal approach. Measurements were obtained during breath-hold to minimize motion artifacts. A homogeneous region of interest (ROI) was placed within the splenic parenchyma, avoiding vessels.

Biochemical Parameters

Laboratory investigations included:

- AST
- ALT
- Serum albumin

Reference Standard

Presence of esophageal varices was confirmed by upper gastrointestinal endoscopy.

Statistical Analysis

Data were expressed as mean ± standard deviation. Comparisons between groups were performed using appropriate statistical tests. Receiver operating characteristic (ROC) curve analysis was used to determine diagnostic performance. A p-value < 0.05 was considered statistically significant.

Results

Patient Characteristics

The study included 70 patients (mean age: 51.34 ± 10.04 years), with a male predominance (74.3%). Esophageal varices were present in 50% of patients.

Alcoholic liver disease was the most common etiology (65.7%), followed by non-alcoholic fatty liver disease and viral hepatitis.

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Spleen stiffness values were significantly higher in patients with esophageal varices compared to those without:

- 33.65 ± 3.09 kPa vs. 25.16 ± 1.79 kPa
- $p < 0.001$

Diagnostic Performance

ROC analysis demonstrated excellent diagnostic performance:

1. AUC = 1.00
2. Cutoff: >29.31 kPa
3. Sensitivity: 100%
4. Specificity: 100%

Treatment Response

Spleen stiffness showed a significant reduction following treatment:

- 29.40 ± 4.95 kPa → 26.75 ± 4.41 kPa
- $p < 0.001$

Comparison with Other Parameters

Spleen stiffness demonstrated superior diagnostic accuracy compared to:

1. Portal vein diameter
2. Spleen size
3. Biochemical markers

Discussion

This study demonstrates that spleen stiffness measured by shear wave elastography is a highly accurate non-invasive biomarker for predicting esophageal varices in patients with chronic liver disease.

The strong diagnostic performance observed (AUC = 1.00) highlights the potential of SSM as a reliable surrogate for portal hypertension. These findings are consistent with previous studies that have shown a close correlation between splenic stiffness and portal venous pressure.

Unlike liver stiffness, spleen stiffness reflects both vascular congestion and portal hemodynamics, making it a more specific indicator of clinically significant portal hypertension.

Additionally, the observed reduction in spleen stiffness following treatment suggests that SWE can be used for monitoring therapeutic response.

Clinical Implications

1. May reduce need for routine endoscopy
2. Useful for screening and follow-up
3. Cost-effective and non-invasive

Limitations

1. Small sample size
2. Single-center study
3. Lack of HVPG correlation

Future multicenter studies with larger cohorts are needed to validate these findings.

Conclusion

Spleen stiffness measurement using shear wave elastography is a reliable, reproducible, and non-invasive imaging biomarker for assessing portal hypertension and predicting esophageal varices in chronic liver disease. Its incorporation into routine ultrasonography protocols may improve risk stratification and reduce reliance on invasive procedures.

Ethics Statement

This study was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants.

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