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Original Research Article

DIAGNOSTIC ACCURACY OF TRANSABDOMINAL ULTRASONOGRAPHIC ESOPHAGEAL WALL THICKNESS FOR DETECTING ESOPHAGEAL VARICES IN CIRRHOSIS: A MULTICENTER STUDY

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ABSTRACT

Background: Esophageal varices complicate portal hypertension in cirrhosis. Endoscopy is invasive and sometimes unavailable. We determined the diagnostic accuracy of transabdominal ultrasonographic esophageal wall thickness for detecting esophageal varices.

Materials and Methods: This multicenter cross-sectional study was conducted in radiology departments from March to September 2025. A total of 203 adults aged 30–65 years with ultrasonographically and biochemically diagnosed cirrhosis and portal vein diameter greater than 13 mm were enrolled consecutively. A consultant radiologist measured distal esophageal wall thickness; a value greater than 6 mm, with or without wall irregularity, constituted a positive ultrasound result. A blinded consultant gastroenterologist performed upper gastrointestinal endoscopy as the reference standard.

Results: The mean age was 49.82 ± 6.12 years; 124 (61.1%) participants were male. Ultrasound was positive in 48 (23.6%), whereas endoscopy identified varices in 56 (27.6%). The 2 × 2 distribution comprised 47 true-positive, 146 true-negative, one false-positive, and nine false-negative results. Sensitivity was 83.9%, specificity 99.3%, positive predictive value 97.9%, negative predictive value 94.1%, and overall accuracy 95.1%. Sensitivity and specificity were 82.9% and 98.9% in males and 85.7% and 100% in females, respectively.

Conclusion: Distal esophageal wall thickness greater than 6 mm demonstrated high specificity and good sensitivity. It may support noninvasive triage where endoscopic access is constrained but should not replace clinically indicated endoscopy.

Keywords: Cirrhosis; endoscopy; esophageal varices; esophageal wall thickness; portal hypertension; ultrasonography.

INTRODUCTION

Cirrhosis represents the final common pathway of many chronic liver diseases and imposes substantial mortality, disability, and healthcare costs worldwide, with the greatest proportional burden falling on low- and middle-income countries where timely specialist services are often limited.[1] Progressive fibrosis, nodular architectural distortion, increased intrahepatic vascular resistance, and splanchnic vasodilatation produce portal hypertension, the principal driver of ascites, hepatic encephalopathy, gastroesophageal varices, variceal hemorrhage, and other clinically important decompensating events.[2]

Clinically significant portal hypertension marks a major transition in the natural history of cirrhosis because it predicts variceal formation and decompensation and therefore increasingly guides risk stratification, surveillance, and preventive treatment decisions.[3] Gastroesophageal varices are frequent in cirrhosis, and their likelihood rises with worsening liver dysfunction, while variceal hemorrhage remains an acute medical emergency associated with meaningful early mortality despite advances in vasoactive therapy, endoscopic control, antibiotics, and rescue shunting.[4]

Contemporary consensus recommends identifying patients who require primary prophylaxis while reducing unnecessary procedures in low-risk compensated disease through validated noninvasive criteria that combine liver stiffness, platelet count, and, in selected settings, spleen stiffness.[5] Esophagogastroduodenoscopy remains the clinical reference standard because it directly demonstrates varices, permits assessment of size and bleeding stigmata, and enables treatment, but it requires trained personnel, disinfection infrastructure, patient preparation, and procedural tolerance.[6]

Endoscopic capacity is unevenly distributed in resource-constrained health systems, and repeated screening can increase cost, waiting time, travel, and patient reluctance, making reliable, inexpensive triage approaches particularly relevant to Pakistani hospitals.7 Conventional ultrasonography is widely available, nonionizing, repeatable, and comparatively affordable, and it already forms part of routine evaluation of cirrhotic morphology, ascites, splenomegaly, portal vein caliber, flow direction, and portosystemic collateral pathways.[8] Noninvasive tests cannot yet reproduce every function of endoscopy, but combinations of laboratory, clinical, and imaging measurements can identify groups with a sufficiently low probability of high-risk varices to avoid or defer selected endoscopic examinations.[9]

Liver and spleen stiffness measurements have shown useful diagnostic performance for clinically significant portal hypertension and high-risk varices, although equipment, operator expertise, technical failure, and etiology-specific thresholds may limit universal application.[10] Doppler-derived portal venous indices and anatomic sonographic findings have also been investigated, but variations in acquisition technique, respiration, hemodynamic status, disease severity, and reference thresholds have produced heterogeneous estimates across studies.[11] Direct assessment of the distal esophageal wall offers a conceptually simple alternative because submucosal venous dilatation can increase wall thickness or create surface irregularity that may be visible through a transabdominal acoustic window.[12] A highly specific sonographic sign could be especially valuable for prioritizing endoscopy in crowded radiology and gastroenterology services, whereas adequate sensitivity and a high negative predictive value would be necessary if the method were used to defer invasive testing.[13,14]

The present study therefore evaluated the diagnostic accuracy of distal esophageal wall thickness greater than 6 mm on transabdominal ultrasound for detecting endoscopically confirmed esophageal varices in adults with cirrhosis attending multicenter tertiary-care hospitals in Pakistan, using a prespecified protocol suitable for routine radiology practice.

MATERIALS AND METHODS

This multicenter cross-sectional diagnostic-accuracy study was conducted in the radiology departments of participating tertiary-care hospitals in Pakistan from March to September 2025. The protocol was approved by the institutional ethics committees of the participating hospitals before enrollment. The study was performed in accordance with the Declaration of Helsinki. Each participant received an explanation of the purpose, procedures, potential inconvenience, and confidentiality safeguards, and written informed consent was obtained before data collection.

The target population comprised adults with established liver cirrhosis referred from outpatient and inpatient services for imaging assessment. The required sample size was 203, calculated using an expected sensitivity of 97%, expected specificity of 93%, expected prevalence of esophageal varices of 50%, desired precision of 5%, and 95% confidence level. Participants were recruited through non-probability consecutive sampling until the required sample was achieved.

Patients aged 30–65 years of either sex were eligible when cirrhosis had been diagnosed using ultrasonographic and laboratory findings and the portal vein diameter was greater than 13 mm. Patients were excluded if they had experienced one or more previous episodes of upper gastrointestinal bleeding, had coexisting cardiac or respiratory illness, or were younger than 30 years or older than 65 years. A brief clinical history and demographic information were recorded on a structured proforma after eligibility confirmation. Pre specified study variables and operational definitions are given in [Table 1].

Table 1: Prespecified study variables and operational definitions

Variable	Operational definition
Cirrhosis	Ultrasonographic and laboratory diagnosis with portal vein diameter greater than 13 mm
Positive ultrasound	Distal esophageal wall thickness greater than 6 mm, with or without wall irregularity
Positive reference standard	Esophageal varices visualized on upper gastrointestinal endoscopy
True positive	Positive findings on both ultrasound and endoscopy

True negative	Negative findings on both ultrasound and endoscopy
False positive	Positive ultrasound with negative endoscopy
False negative	Negative ultrasound with positive endoscopy

Transabdominal ultrasonography was performed without charge by consultant radiologists with at least three years of post-fellowship experience. The distal intra-abdominal esophagus was assessed through an appropriate transabdominal window, and esophageal wall thickness was measured in millimeters. The wall contour was also examined for irregularity. Esophageal wall thickness greater than 6 mm, with or without wall irregularity, was prospectively classified as a positive ultrasound result. A measurement of 6 mm or less without the qualifying finding was considered negative. The findings were entered on the study proforma before the endoscopic result was reviewed.

Upper gastrointestinal endoscopy was performed by consultant gastroenterologists with at least three years of post-fellowship experience. The gastroenterologists were blinded to the ultrasound findings to minimize review bias. Direct endoscopic visualization of esophageal varices constituted a positive reference-standard result, whereas the absence of varices constituted a negative result. Endoscopic findings were retrieved from the medical record and recorded on the study proforma.

A true-positive result was defined as varices detected by both ultrasound and endoscopy, while a true-negative result was defined as the absence of varices on both examinations. A false-positive result represented wall thickness greater than 6 mm on ultrasound without endoscopic varices, whereas a false-negative result represented negative ultrasound findings despite endoscopically demonstrated varices.

The primary outcome measures were sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. Sex-stratified diagnostic tables were also examined to determine whether test performance differed between male and female participants.

Data were analyzed using SPSS version 20.0. Continuous and categorical variables were summarized using descriptive statistics. Sensitivity, specificity, predictive values, and overall diagnostic accuracy were calculated using endoscopy as the reference standard. Age- and sex-based stratification was performed, with $p \leq 0.05$ considered statistically significant.

RESULTS

All 203 enrolled participants completed both transabdominal ultrasonography and upper gastrointestinal endoscopy and were included in the final analysis. The study population was predominantly older than 40 years, with a higher proportion of male participants. The demographic characteristics of the participants are presented in [Table 2].

Table 2: Demographic characteristics of the participants (n=203)

Characteristic	Frequency	Percentage/summary
Age, years	203	49.82 ± 6.12
Age range, years	—	30–60
Age ≤40 years	13	6.4%
Age >40 years	190	93.6%
Male	124	61.1%
Female	79	38.9%

The distribution of positive and negative findings on ultrasonography and endoscopy is illustrated in [Figure 1]. Endoscopy identified slightly more positive cases than ultrasonography, while negative findings predominated with both diagnostic methods.

Cross-tabulation of the index test against the reference standard demonstrated a high level of agreement between ultrasonography and endoscopy. Only ten examinations showed discordant findings, consisting mainly of false-negative results. The complete diagnostic classification is presented in [Table 3].

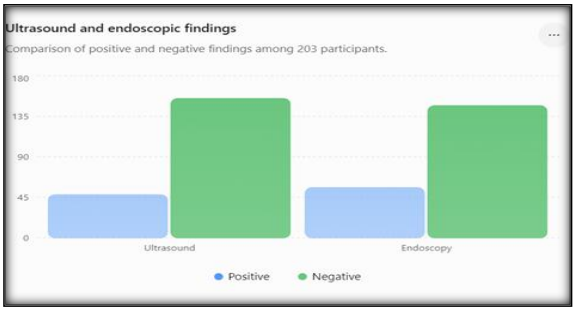

Figure 1: Distribution of ultrasonographic and endoscopic findings among the participants.

Table 3: Diagnostic comparison of ultrasonography with endoscopy

Ultrasonography result	Endoscopy positive	Endoscopy negative	Total
Positive	47	1	48
Negative	9	146	155
Total	56	147	203

Based on the paired diagnostic findings, distal esophageal wall thickness greater than 6 mm demonstrated good sensitivity, excellent specificity, and high predictive values. The overall diagnostic accuracy was 95.1%, indicating close agreement between ultrasonography and the endoscopic reference standard.

Sex-stratified analysis showed broadly comparable diagnostic performance among male and female participants. Specificity and positive predictive value were slightly higher among females because no false-positive result occurred in this subgroup. However, these subgroup findings should be interpreted cautiously because of the relatively small number of endoscopy-positive cases. The sex-stratified diagnostic measures are summarized in [Table 4].

Table 4: Sex-stratified diagnostic performance of ultrasonography

Diagnostic measure	Male, %	Female, %	Overall, %
Sensitivity	82.9	85.7	83.9
Specificity	98.9	100.0	99.3
Positive predictive value	96.7	100.0	97.9
Negative predictive value	93.6	95.1	94.1
Diagnostic accuracy	94.4	96.2	95.1

Overall, ultrasonography correctly classified 193 of the 203 participants. Its diagnostic performance was characterized by very few false-positive findings, while most discordant examinations resulted from failure to detect endoscopically confirmed varices.

DISCUSSION

This multicenter study found that distal esophageal wall thickness greater than 6 mm had 83.9% sensitivity, 99.3% specificity, 97.9% positive predictive value, 94.1% negative predictive value, and 95.1% diagnostic accuracy against endoscopy, supporting its value as a highly specific radiological marker rather than a complete replacement for endoscopic assessment.

The observed prevalence of endoscopic varices was 27.6%, which is compatible with the variation expected across cirrhotic populations because prevalence depends on compensation status, etiology, disease severity, referral patterns, and whether studies evaluate all varices or only varices requiring treatment.[15] The high specificity is clinically useful in resource-limited Pakistani hospitals because a positive examination could help prioritize patients for gastroenterology referral and endoscopy.[16] However, the nine false-negative results demonstrate that clinical suspicion, hepatic decompensation, bleeding risk, and guideline-based indications must take priority over a negative ultrasound result.

The findings complement contemporary noninvasive strategies, including the Baveno criteria based on liver stiffness and platelet count.[17] However, esophageal wall thickness evaluates a local anatomical consequence of variceal dilatation and may be more feasible in hospitals where elastography is unavailable or technically unsuccessful.

A recent meta-analysis reported good diagnostic performance of point and two-dimensional shear-wave elastography for identifying high-risk esophageal varices.[18] Nevertheless, the pooled estimates and diagnostic thresholds varied among the included studies, emphasizing that each sonographic technique requires standardized acquisition and external validation before it can independently direct clinical care.

A contemporary Pakistani study showed that composite noninvasive indices and splenic stiffness could help predict high-risk esophageal varices in patients with cirrhosis.[19] These findings reinforce the local need for noninvasive triage and suggest that combining esophageal wall thickness with clinical, laboratory, or stiffness measurements might provide better diagnostic performance than using a single parameter.

Doppler-derived portal flow measurements have also produced encouraging diagnostic results in Pakistani patients with cirrhosis.[20] However, Doppler measurements can be influenced by respiration, the angle of insonation, fasting status, cardiac function, and the presence of collateral circulation.[20] A simple morphological measurement of the distal esophageal wall may therefore provide a practical complementary finding.

Computed tomography can demonstrate gastroesophageal varices with high diagnostic performance and may provide useful information when it is already clinically indicated. Nevertheless, exposure to ionizing radiation, contrast-related risks, cost, and limited justification for repeated screening favor ultrasonography as an initial imaging approach.[21] The similar sex-stratified sensitivity and specificity values observed in this study suggest that there was no major difference in diagnostic performance between males and females.[22] However, these subgroup estimates were based on relatively small numbers of positive cases, and the observed specificity of 100% in females should not be interpreted as proof of superior diagnostic performance in women.

The strengths of the study included paired ultrasound and endoscopic examinations in all participants, blinded reference-standard assessment, experienced radiologists and gastroenterologists, a prespecified 6-mm threshold, and preservation of a complete 2 × 2 diagnostic table. These characteristics are consistent with recommended

reporting principles for diagnostic-accuracy studies.[23]

Further prospective studies involving additional Pakistani hospitals are required to validate the 6-mm threshold. Future research should evaluate inter observer reproducibility, operator training, disease-spectrum effects, clinically significant variceal grades, and the performance of esophageal wall thickness when combined with Doppler, platelet count, or elastography measurements.

CONCLUSION

Transabdominal ultrasonographic measurement of distal esophageal wall thickness demonstrated good sensitivity and excellent specificity for detecting esophageal varices in adults with cirrhosis. A wall thickness greater than 6 mm may provide a practical, accessible, and noninvasive method for prioritizing patients for endoscopy, particularly in resource-constrained Pakistani hospitals. However, because some cases were missed on ultrasonography, it should be used as a complementary screening tool rather than a replacement for upper gastrointestinal endoscopy. Further large-scale prospective multicenter studies are recommended to validate the 6-mm cut-off, evaluate interobserver reproducibility, and assess whether combining this measurement with other noninvasive parameters can improve diagnostic accuracy.

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