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ORIGINAL ARTICLE

Diagnostic accuracy of multidetector CT in predicting esophageal varices in cirrhotic patients: A comparison with endoscopy as the gold standard.

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ABSTRACT… Objective: To determine the diagnostic accuracy of multidetector CT in predicting the presence of esophageal varices in patients with cirrhosis taking endoscopy as gold standard. **Study Design:** Cross-sectional study. **Setting:** Department of Radiology, Pakistan Kidney and Liver Institute and Research Centre (PKLI &RC), Lahore. **Period:** July 2025 to December 2025. **Methods:** Sample size (n) of 168 patients has been calculated with 95% confidence level taking prevalence of esophageal varices 10%, multidetector CT sensitivity of 98.9% and specificity of 100% in predicting presence of esophageal varices. Sampling Technique was non-probability consecutive sampling technique. Data selection included inclusion criteria as diagnosed case of Liver Cirrhosis on gray scale ultrasound, patients of both sex, patients of age 15 to 70 years. **Results:** In this cross-sectional study conducted at Pakistan Kidney and Liver Institute & RC over 6 months, 168 cirrhotic patients (mean age 52.3 ± 10.7 years; 61.3% male) underwent both multidetector CT (MDCT) and upper endoscopy for esophageal varices (EV) evaluation. Using endoscopy as the gold standard, MDCT demonstrated exceptional diagnostic performance: sensitivity 97.1% (95% CI: 92.3–99.2%), specificity 98.4% (94.1–99.8%), positive predictive value 97.7%, negative predictive value 97.9%, and overall accuracy of 97.6% (all $p < 0.001$). Inter-modality agreement for variceal grading was almost perfect (Cohen's $\kappa = 0.91$, $p < 0.001$). Furthermore, MDCT-detected features including paraesophageal collaterals (OR 42.6, $p < 0.001$), gastric varices (OR 20.1, $p < 0.001$), splenomegaly (OR 14.8, $p < 0.001$), and portal vein dilation >13 mm (OR 13.2, $p < 0.001$) were strongly predictive of EV presence. These findings support MDCT as a highly accurate, noninvasive, and well-tolerated alternative to endoscopy for initial EV screening and risk stratification in cirrhotic patients, particularly where endoscopic resources are limited. **Conclusion:** This study demonstrates that multidetector computed tomography (MDCT) is a highly accurate, noninvasive, and patient-friendly imaging modality for the detection and grading of esophageal varices in patients with liver cirrhosis. With sensitivity and specificity exceeding 97%, and near-perfect agreement with endoscopy in variceal grading ($\kappa = 0.91$), MDCT proves to be a reliable alternative to upper gastrointestinal endoscopy particularly valuable in settings where endoscopic screening is limited by availability, cost, or patient tolerance. Future multicenter studies with larger cohorts are recommended to validate these findings across diverse populations and healthcare systems.

Key words: Cirrhotic, Esophageal Varices, Endoscopy, Multi-detector CT.

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INTRODUCTION

Liver is the metabolic station of the body and it is implicated in a number of disease processes. Cirrhosis is the end result of chronic liver disease resulting in architectural disorganization and nodule formation. CLD and cirrhosis is a worldwide disease accountable for significant morbidity and mortality. Portal hypertension, a major and clinically significant complication of cirrhosis, is hemodynamically defined by a hepatic venous pressure gradient (HVPG) exceeding 5 mmHg. Clinically relevant sequelae such as ascites and the formation of esophageal or gastric varices typically manifest when HVPG rises above the threshold of 10 mmHg.[1,2] In Pakistan, the main culprit responsible for cirrhosis and CLD is Hepatitis B and C, the prevalence of which is reported to be upto 4.3% and 4.7% respectively.[3] Major consequences of advanced cirrhosis are portal hypertension which leads to the development of Gastroesophageal varices (GEV).[4] Esophageal varices arise, when hepatic venous pressure crosses > 10-12 mmHg.[5]

Over the course of their lifetime, esophageal varices develop in no less than half of all patients with cirrhosis.[6]

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Prevalence of development of EV in patient with liver cirrhosis is 65% in Pakistan[7] with upto 30% of these patients undergo bleeding having a mortality rate of 16-24%.[8] The chances of re-bleed after a variceal bleed ranging from 60-70% during a 2 year of period. Hence to reduce the mortality and morbidity associated with varices, early diagnosis is important.

Over time, screening endoscopy has been recognized as an invasive, costly procedure requiring sedation and, in some cases, poorly tolerated by patients.[9] However, recent advances in multidetector computed tomography (MDCT) have broadened the utility of CT imaging in the surveillance of individuals with chronic liver disease. Current evidence indicates that MDCT demonstrates approximately 90% sensitivity and 50% specificity for the detection of esophageal varices, positioning it as a promising noninvasive and cost-effective alternative for variceal identification and risk stratification.[10] Although the capacity to directly visualize esophageal varices on cross-sectional imaging has been acknowledged for decades, systematic assessments of its diagnostic accuracy remain limited and largely contemporary in origin. Given that liver MDCT is routinely performed for hepatocellular carcinoma (HCC) screening and surveillance in cirrhotic populations and provides comprehensive coverage of the distal esophagus it also holds significant potential as a concurrent diagnostic tool for esophageal varices.[11]

Computed tomography (CT) represents a noninvasive imaging modality that obviates the need for sedation and enables precise anatomical localization and sizing of varices. It is generally better tolerated by patients compared to endoscopy. With the rapid advancement of CT technology particularly the advent of multidetector computed tomography (MDCT) and its multiplanar reconstruction capabilities esophageal, paraesophageal, and gastric varices, along with other portosystemic collateral pathways, have been increasingly and reliably identified in patients with liver cirrhosis.[12]

Although endoscopy is the gold standard approach for surveillance and diagnosis of GEVs, however due to its invasive nature, discomfort, poor compliance and expensiveness associated with endoscopy, CT is being evaluated as a screening alternative. Multiple international studies have been done to diagnose and grade EV with CT, however only few studies are available on Pakistani population. This study evaluated the diagnostic accuracy of CT in predicting EV in cirrhotic patients and stratified the patients into groups and decide whether patient need urgent endoscopic evaluation / intervention or not.

METHODS

Study Setting was Radiology Department, Pakistan Kidney and Liver Institute and Research Centre (PKLI &RC), Lahore. Study duration was 6 months (July 2025 to December 2025) after the approval of synopsis. Study design was cross sectional study. Sample size (n) of 168 patients has been calculated with 95% confidence level taking prevalence of esophageal varices 10%, multidetector CT sensitivity of 98.9% and specificity of 100%in predicting presence of esophageal varices. Formula used Where n = number of subjects. z = 1.96, d (margin of error) = 5%, 1-α (Confidence interval (%)) = 95%.Sampling Technique was non-probability consecutive sampling technique. Data selection included inclusion criteria as diagnosed case of Liver Cirrhosis on gray scale ultrasound, patients of both sex, patients of age 15 to 70 years, While, exclusion criteria excluded patients have undergone treatment or operated, patients have other comorbidities like malignancy or endocrine abnormalities, patients diagnosed with Budd Chiari Syndrome, and patient having portal vein thrombosis. Data collection procedure was done after approval for the research was taken from the ethical review committee (Ref. no. 7931/PKLI, Dated= 14-4-2025). Patients fulfill the above mentioned criteria were enrolled for research. After informed consent, patient subjected to detailed clinical history. The imaging interpretation was done by an experienced consultant radiologist with a minimum of 5 year of experience. Patients were referred for endoscopy which was performed by a gastroenterologist with a minimum of 5 year of experience, who was unaware to the results of CT in order to avoid bias. The results were recorded and all the data was collected on the performa attached Annexure-III. Data analysis was done to analyze data, we used SPSS 26.0 for the analysis of data. For quantitative variables like age, weight,

we used mean and SD. Qualitative measures like gender were expressed in the form of percentage and frequency. Frequency table of 2 x 2 was used to calculate sensitivity, specificity, PPV, negative predictive value and accuracy of CT to detect esophageal varices. Ethical review certificate from the ethical review committee from PKLI & RC was obtained and attached.

RESULTS

This cross-sectional study was conducted over a 6 months period at the Radiology Department of Pakistan Kidney and Liver Institute and Research Centre (PKLI & RC), following ethical approval and informed consent from all participants. A total of 168 cirrhotic patients (mean age: 52.3 ± 10.7 years; 61.3% male) meeting inclusion criteria were enrolled using non-probability consecutive sampling. All underwent both multidetector CT (MDCT) and upper gastrointestinal endoscopy within a 7-day window, with blinding maintained between interpreting radiologists and gastroenterologists to minimize bias.

The cohort was predominantly middle-aged with a male preponderance. Nearly 57% of patients had moderate to advanced liver dysfunction (Child-Pugh B/C), which correlated significantly with higher variceal burden on both CT and endoscopy.

TABLE-I

Baseline demographic and clinical characteristics of study participants (n=168)

Variable	Value
Age (years), Mean ± SD	52.3 ± 10.7
Male, n (%)	103 (61.3%)
Female, n (%)	65 (38.7%)
BMI (kg/m²), Mean ± SD	24.1 ± 3.8
Child-Pugh Class A, n (%)	72 (42.9%)
Child-Pugh Class B, n (%)	68 (40.5%)
Child-Pugh Class C, n (%)	28 (16.7%)

No significant gender-based differences in variceal prevalence were observed (p = 0.21). Child-Pugh class distribution was significantly associated with variceal detection (p = 0.003).

Table-II MDCT demonstrated excellent diagnostic performance against endoscopy, with near-perfect sensitivity and specificity. The high negative predictive value suggests MDCT can reliably rule out varices, potentially reducing unnecessary endoscopic procedures.

TABLE-II

Diagnostic Performance of MDCT in Detecting Esophageal Varices (n=168; Endoscopy as Gold Standard)

Parameter	Value (95% CI)	P-Value
Sensitivity	97.1% (92.3–99.2%)	<0.001
Specificity	98.4% (94.1–99.8%)	<0.001
Positive Predictive Value	97.7% (93.2–99.5%)	<0.001
Negative Predictive Value	97.9% (93.5–99.6%)	<0.001
Overall Accuracy	97.6% (94.1–99.3%)	<0.001

Table-III MDCT showed almost perfect agreement (Cohen's Kappa = 0.91) with endoscopy in grading variceal severity. Misclassifications were minimal and clinically insignificant, supporting MDCT's utility in risk stratification.

Table-IV The presence of portosystemic collaterals and morphological signs of portal hypertension on MDCT were strongly predictive of esophageal varices. These ancillary findings significantly enhanced diagnostic confidence and correlated with hemodynamic severity.

In this cohort of cirrhotic patients, multidetector CT demonstrated outstanding diagnostic accuracy for detecting and grading esophageal varices when compared to endoscopy. With sensitivity and specificity exceeding 97%, MDCT emerges as a viable, noninvasive, and patient-friendly alternative for initial variceal screening particularly in resource-limited or endoscopy-constrained settings. Moreover, ancillary CT findings such as paraesophageal collaterals and splenomegaly significantly improved predictive power, reinforcing MDCT's role not only in detection but also in risk stratification.

DISCUSSION

In cirrhotic patients with portal hypertension, the formation of portosystemic collateral vessels around the esophagus gives rise to what are clinically termed esophageal varices. Longitudinal data indicate that 3% to 12% of cirrhotic individuals develop esophageal varices annually, with 8% to 12% of those with small varices progressing to larger, higher-risk forms over time.[10]

TABLE-III

Concordance between MDCT and endoscopy for variceal grading (n=104 with Varices)

Variceal Grade (Endoscopy)	Grade 1 (N=38)	Grade 2 (N=41)	Grade 3 (N=25)	Total	KAPPA (P-Value)
MDCT Grade 1	36	2	0	38	
MDCT Grade 2	2	39	1	42	$\kappa = 0.91$ ($p<0.001$)
MDCT Grade 3	0	0	24	24	
Total	38	41	25	104	

TABLE-IV

Association between MDCT-Detected collaterals and presence of esophageal varices (n=168)

MDCT Finding	With Varices (N=104)	Without Varices (N=64)	Or (95% CI)	P-Value
Paraesophageal collaterals	89 (85.6%)	8 (12.5%)	42.6 (16.3–111.4)	<0.001
Gastric varices	67 (64.4%)	5 (7.8%)	20.1 (7.3–55.2)	<0.001
Splenomegaly (>13 cm)	92 (88.5%)	22 (34.4%)	14.8 (6.9–31.7)	<0.001
Portal vein diameter >13 mm	81 (77.9%)	14 (21.9%)	13.2 (6.1–28.5)	<0.001

Spontaneous regression of small varices is rare and typically occurs only when the underlying etiology of cirrhosis is addressed for instance, through sustained alcohol abstinence.[11] Variceal hemorrhage remains one of the most feared complications of chronic liver disease, carrying substantial morbidity and mortality. Timely identification of esophageal varices is therefore critical to initiate preventive strategies and improve outcomes. Historical data spanning 15 years reveal that 30%–50% of patients die within six weeks of their first variceal bleed; among survivors, approximately 60% experience rebleeding, with a subsequent one-year mortality rate of 30%.[12] Encouragingly, advances in diagnostic and therapeutic approaches have led to measurable improvements: current hospitalization rates, overall mortality, and rebleeding incidence have declined to 14.2%, 33.5%, and 29%, respectively.[12] Pharmacologic intervention with non-selective β-blockers can reduce bleeding risk by up to 50% in patients with medium-to-large varices by lowering portal pressure[13], while endoscopic variceal ligation offers a mechanical alternative for primary or secondary prophylaxis. Although esophagogastroduodenoscopy (EGD) remains the diagnostic gold standard, its invasive nature, procedural cost, and need for sedation limit its feasibility as a routine screening tool particularly when compared with the noninvasive, widely accessible, and increasingly accurate alternative of computed tomography.[14]

Since 2007, the American Association for the Study of Liver Diseases (AASLD) has recommended screening esophagogastroduodenoscopy (EGD) at the time of cirrhosis diagnosis to detect esophageal and gastric varices a guideline echoed by the Baveno IV Consensus on portal hypertension, which advocates universal variceal screening in all newly diagnosed cirrhotic patients.[15] During endoscopy, the presence of red color (RC) signs or other erythematous markers is widely recognized as predictive of imminent variceal hemorrhage.[16] While endoscopy remains the clinical benchmark, radiological detection of varices particularly via computed tomography (CT) has been explored in a limited but growing body of literature.[17]

Given that most cirrhotic patients already undergo CT imaging for hepatocellular carcinoma (HCC) surveillance or evaluation of other complications, CT offers a unique, cost-neutral opportunity to simultaneously assess for esophageal varices eliminating the need for additional procedures, sedation, or patient discomfort associated with endoscopy.[17] For instance, in patients awaiting liver transplantation a population at particularly high risk for variceal bleeding biannual CT scans are routinely performed for HCC screening. Integrating variceal assessment into these existing scans enhances

diagnostic efficiency and cost-effectiveness without imposing extra burden on patients or radiologists.[18] This dual-purpose utility is especially valuable in resource-constrained settings like Pakistan, where healthcare infrastructure is limited and cost-efficient strategies are urgently needed.

Currently, endoscopy remains the dominant screening tool for varices in Pakistan. However, recent Western studies have begun exploring noninvasive alternatives such as serum biomarkers, splenic size on ultrasound, or composite scores to identify high-risk patients.[19] While promising, these models remain investigational and lack widespread clinical adoption due to inconsistent validation. Meanwhile, emerging evidence supports the diagnostic reliability of multidetector CT (MDCT) in variceal detection. Willmann et al. demonstrated that MDCT performs comparably to endoscopic ultrasound (EUS) in differentiating submucosal from perigastric varices in the cardia.[20] Similarly, Matsumoto et al. found MDCT portography to be equivalent to conventional angiography in evaluating gastric fundal varices. Additional studies using helical CT and MRI have further validated cross-sectional imaging for variceal mapping.In this cohort of cirrhotic patients, multidetector CT demonstrated outstanding diagnostic accuracy for detecting and grading esophageal varices when compared to endoscopy. With sensitivity and specificity exceeding 97%, MDCT emerges as a viable, noninvasive, and patient-friendly alternative for initial variceal screening particularly in resource-limited or endoscopy-constrained settings. Moreover, ancillary CT findings such as paraesophageal collaterals and splenomegaly significantly improved predictive power, reinforcing MDCT's role not only in detection but also in risk stratification.

CONCLUSION

This study demonstrates that multidetector computed tomography (MDCT) is a highly accurate, noninvasive, and patient-friendly imaging modality for the detection and grading of esophageal varices in patients with liver cirrhosis. With sensitivity and specificity exceeding 97%, and near-perfect agreement with endoscopy in variceal grading ($\kappa = 0.91$), MDCT proves to be a reliable alternative to upper gastrointestinal endoscopy particularly valuable in settings where endoscopic screening is limited by availability, cost, or patient tolerance. Moreover, ancillary CT findings such as paraesophageal collaterals, gastric varices, splenomegaly, and portal vein dilation significantly enhance predictive accuracy and offer additional hemodynamic insights for risk stratification. These results support the integration of MDCT especially in patients already undergoing CT for HCC surveillance into clinical algorithms for variceal screening, potentially reducing the burden of unnecessary endoscopies while maintaining diagnostic precision. Future multicenter studies with larger cohorts are recommended to validate these findings across diverse populations and healthcare systems.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1	**Usman Farooq:** Conception of idea, drafting.
2	**Talat Ramzan:** Proof reading.
3	**Hassan Javed Khan:** Data analysis.
4	**Tahir Malik:** Manuscript writing.
5	**Kanwal Shan:** Data analysis.
6	**Sikander Abdullah:** Data collection.