Role of Enhanced Computed Tomography Versus Upper Endoscopy in Diagnosis and Grading of Esophageal Varices

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Abstract

Background: Cirrhosis is often complicated by oesophageal varices (EVs). The use of oesophago-gastro-duodenoscopy (EGD) as a screening method is limited by its invasiveness, expense, requirement for sedation, and poor patient acceptance of the procedure. In contrast, Multidetector Computed Tomography (MDCT) imaging is non-invasive, does not necessitate sedation, and allows accurate assessment of the variceal site and size. It is also better tolerated by patients than EGD.

Aim: To assess the efficacy of MDCT in evaluating the EVs.

Patients and method: The study was a descriptive comparative study conducted on 60 cases with cirrhosis due to chronic HCV. The studied patients were subjected to history taking, clinical examination, MDCT, and EGD.

Results: The agreement between MDCT and EGD in assessing the risk of EVs was excellent (kappa=0.960 and $P < 0.001$). Of the 60 patients, MDCT correctly identified all 12 patients without varices (true negatives). Among low-risk varices, 4 patients were correctly classified by MDCT (true positives), while 2 cases were underestimated as negative (false negatives). All 44 patients with high-risk varices were correctly detected by MDCT (true positives). The total CT sensitivity for detecting EVs was 96.0%, with 100% specificity and 96.6% accuracy.

Conclusion: MDCT was an excellent diagnostic alternative to conventional EGD for detecting and grading EVs in cirrhotic patients.

Keywords: Cirrhosis, Endoscopy, Computed Tomography, Portal hypertension.

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Introduction

Liver cirrhosis is pathologically defined as persistent fibrosis and inflammation of the liver and can result from many causes, such as chronic hepatitis B or C infection, non-alcoholic steatohepatitis, or chronic alcohol abuse.[(1)] In cirrhotic patients, oesophageal varices (EVs) are submucosal distal esophageal veins connecting the portal and systemic circulation (portosystemic collaterals) that develop as a result of portal hypertension.[(2)] Rupture of these varices is the leading cause of upper gastrointestinal bleeding, a life-threatening complication, with a 6-week mortality rate of approximately 20%.[(3, 4)]

Early identification and risk stratification of EVs are crucial for guiding prophylactic therapy. Patients with medium or large varices are candidates for pharmacological or endoscopic prophylaxis, while those with small or absent varices require periodic surveillance to monitor for progression.[(5)]

Esophagogastroduodenoscopy (EGD) remains the gold standard for the detection and grading of EVs. However, routine endoscopic screening is often limited by its invasiveness, need for sedation, high cost, and poor patient compliance, which can lead to delayed diagnosis and inadequate prophylactic intervention. In clinical practice, many patients with cirrhosis undergo repeated EGD examinations, some of which provide limited diagnostic yield.[(4, 6, 7)]

In recent years, several non-invasive methods have been explored to predict the presence and risk of EVs, including ultrasonographic parameters, serum biomarkers, liver and spleen stiffness measurements, platelet-to-spleen diameter ratio, and video capsule endoscopy. While these techniques are less invasive, their accuracy in reliably detecting high-risk varices remains suboptimal, and none can consistently provide an objective measurement of variceal size or morphology.[(8)]

Multidetector computed tomography (MDCT) has emerged as a promising alternative for the evaluation of EVs. MDCT is non-invasive, does not require sedation, and allows high-resolution visualization of the esophagus and peri-esophageal collaterals, enabling objective and reproducible measurement of variceal diameter during routine liver imaging.[(9-11)]

Given the growing burden of cirrhosis-related complications and the limitations of conventional endoscopy, the present study aimed to evaluate the role of MDCT esophagography in detecting esophageal varices and differentiating

small (low-risk) from large (high-risk) gastroesophageal varices, in comparison with the gold standard esophagogastroduodenoscopy.

Patients and Methods:

This descriptive comparative study was conducted at the Radiology Department of Beni-Suef University Hospital over a two-year period from February 2020 to January 2022. Ethical approval was obtained, and informed consent was secured from all participants, with strict confidentiality maintained.

The study included 60 patients with liver cirrhosis who were referred from outpatient clinics and inpatient units of the Internal Medicine and Hepato-gastroenterology Departments. Cirrhosis was diagnosed based on clinical, laboratory, and radiological findings. Patients were excluded if they had active gastrointestinal bleeding at presentation, known hypersensitivity to iodinated contrast agents, prior endoscopic ligation or sclerotherapy, or lower oesophageal malignancy.

All patients underwent detailed clinical evaluation, including comprehensive history taking (personal data, presenting complaints, medical and surgical history, and drug sensitivity) and thorough physical examination. Special emphasis was placed on signs of chronic liver disease and portal hypertension. Routine laboratory investigations were performed, including complete blood count, coagulation profile, liver enzymes, and serum albumin levels.

EGD was carried out for all patients as the reference standard using an OLYMPUS EVIS EXTRA III CV-190 2-channel videoscope (SN:2133741) under propofol sedation (initial bolus of 0.5–1 mg/kg followed by incremental doses of 10–20 mg according to patient response). The oesophageal mucosa was carefully examined for the presence, size, and morphology of varices, and biopsies were obtained when indicated. Varices were graded according to the Japanese classification (grades 1–3)[12] and the modified Paquet classification.[13] Grades II and III varices were considered high-risk for bleeding.

MDCT was performed after endoscopy using a 16-slice CT scanner (Toshiba Alexion). Scanning extended from the diaphragmatic dome to the inferior border of the liver during a single breath-hold. Acquisition parameters included 1–2 mm slice thickness, 1.5 mm reconstruction interval, 140 kV, 200–300 mA, and 0.8-second gantry rotation time. A triphasic contrast-enhanced protocol was applied following intravenous administration of nonionic contrast material (1–2 mL/kg) at a rate of 3 mL/s via a peripheral vein. Imaging was obtained during the arterial phase (20–25 seconds), portal venous phase (60 seconds), and delayed phase (180 seconds). No oral contrast or air insufflation was used to avoid obscuring the oesophageal lumen.

Post-processing was performed on a dedicated workstation, generating axial images (5 mm thickness, 2.5 mm interval) along with coronal and sagittal reformatted images (3 mm thickness). Esophageal varices were identified as enhancing tubular or nodular structures within or adjacent to the oesophageal wall. The maximum short-axis diameter of the largest varix was measured using electronic callipers on PACS. Varices were classified using a 4-point confidence scale: score 1 (<1 mm), score 2 (1–2 mm), score 3 (2–3 mm), and score 4 (>3 mm). A threshold of >2 mm was used to define high-risk varices.[14]

The MDCT findings were correlated with endoscopic results according to predefined criteria to determine diagnostic performance. Patients with no varices on endoscopy corresponded to CT score I and were considered low risk for bleeding. Endoscopic grade I varices correlated with CT scores I and II and were also classified as low risk. In contrast, grade II varices on endoscopy corresponded to CT score III and were considered high risk, while grade III varices correlated with CT score IV and were likewise classified as high risk for bleeding.

Statistical analysis: Statistical analysis was performed using SPSS version 25. Quantitative data were expressed as mean ± standard deviation or median with range, while qualitative data were presented as frequencies and percentages. Comparative analyses were conducted using the independent t-test or Mann–Whitney U test as appropriate, and the chi-square test for categorical variables. Diagnostic accuracy of MDCT was evaluated, with statistical significance set at a p-value ≤ 0.05.

Results

Table 1 summarizes the demographic, laboratory, and extra-esophageal MDCT findings of the study population. A total of 60 patients were included, with a mean age of 57.9 ± 9.9 years (median 56.5; range 33–77); 68.3% were male. Laboratory abnormalities included elevated aspartate aminotransferase (AST) in 20%, anemia in 31.7%, thrombocytopenia in 53.3%, hypoalbuminemia in 21.7%, and coagulation abnormalities in 53.3% of patients. MDCT findings showed hepatomegaly in 71.7%, splenomegaly in 88.3%, and portal vein thrombosis in 21.7%. Ascites was present in 21.7%, hepatic focal lesions suggestive of HCC in 53.3%, and para-esophageal varices in 33.3% of patients.

Table 1. Demographic, Laboratory, and Extra-Esophageal Imaging Findings of the Study Population (n = 60)

Variable	Value (n)	Percentage (%)
Sociodemographic Data		
Age (years)	57.9 ± 9.9	–
Median (range)	56.5 (33–77)	–

Sex		
Male	41	68.3
Female	19	31.7
Laboratory Findings		
AST elevation	12	20.0
Low Hemoglobin	19	31.7
Low Platelet count	32	53.3
Hypoalbuminemia	13	21.7
Coagulation profile abnormality	32	53.3
Extra-Esophageal CT Findings		
Hepatomegaly	43	71.7
Portal vein thrombosis	13	21.7
Splenomegaly	53	88.3
Ascites	13	21.7
Hepatic focal lesions (HCC)	32	53.3
Para-esophageal varices	20	33.3
Urinary bladder mass	1	1.7
Splenic focal lesion	1	1.7
Gallbladder stone	1	1.7

EGD was performed in all 60 patients to assess esophageal varices. Of the cohort, 10 patients (16.6%) had no varices. Low-risk varices (Grade I) were observed in 6 patients (10.0%), while high-risk varices (Grades II and III) were present in 44 patients (73.4%). (Figure 1)

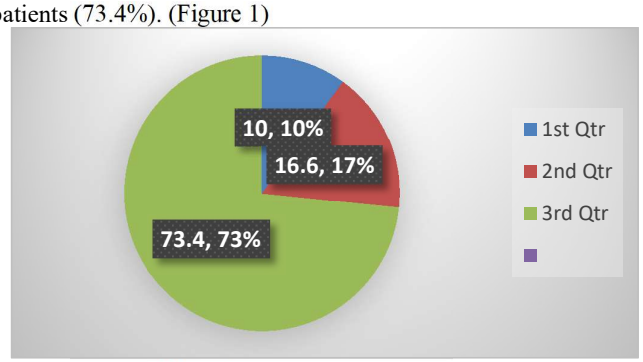

Figure 1. Grades of varices by upper GI endoscope

Using MDCT, the mean maximal diameter of esophageal varices was 4.4 ± 3.1 mm, ranging from 0 to 12 mm. Based on the CT scoring system, 20% of patients had no varices, 6.6% were classified as low-risk (scores I–II), 18.3% as moderate-risk (score III), and 55% as high-risk (score IV). (Figure 2)

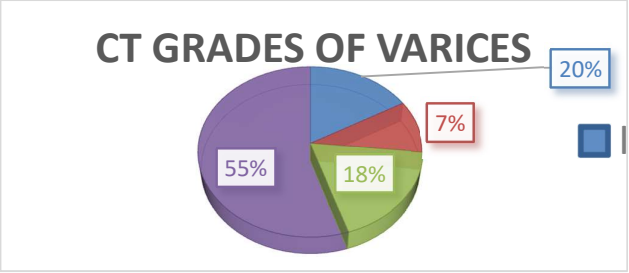

Figure 2. Grades of varices by CT

The agreement between MDCT and EGD in assessing the risk of EVs was excellent. Of the 60 patients, MDCT correctly identified all 12 patients without varices (true negatives) (Figure 3). Among low-risk varices, 4 patients were correctly classified by MDCT (true positives) (Figure 4), while 2 cases were underestimated as negative (false negatives) (Figure 5). All 44 patients with high-risk varices were correctly detected by MDCT (true positives) (Figure 6). Statistical analysis showed a highly significant agreement between MDCT and EGD ($P < 0.001$) with a very high agreement (Kappa = 0.950). (Table 2)

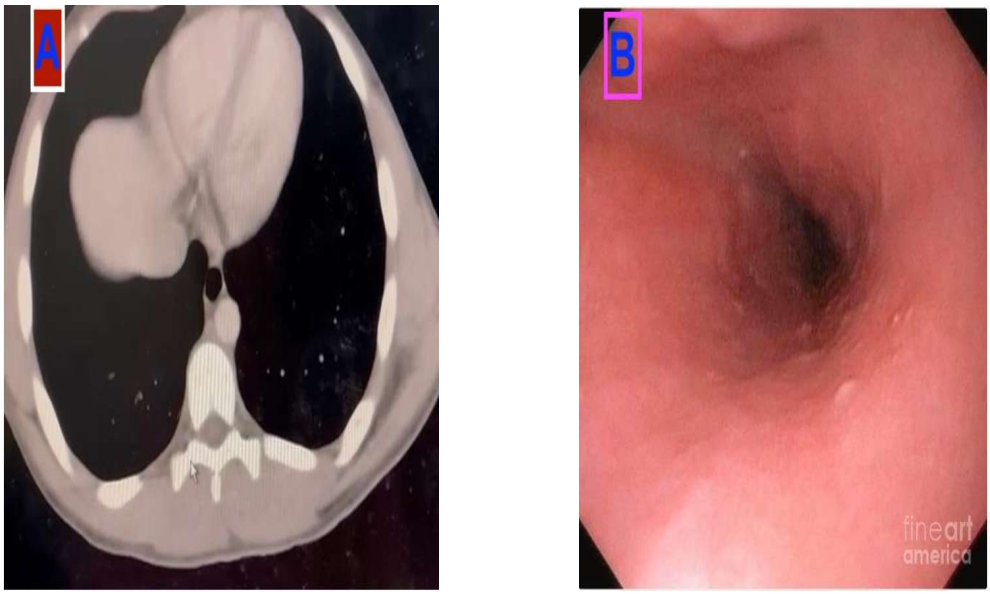

Figure 3. 43-year-old male patient with chronic liver disease on routine endoscopic evaluation. CT: axial cut of triphasic study portal phase showed no varices, score 1 (image A). Endoscopy findings: normal with no esophageal varices (image B).

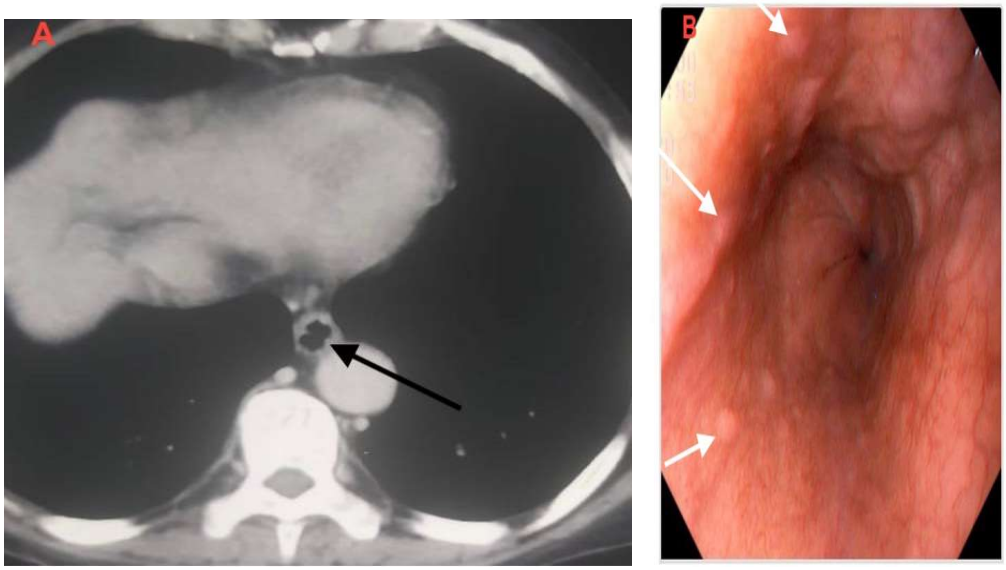

Figure 4. 65 years old male patient with known liver cirrhosis on routine endoscopic evaluation. CT: axial cut of triphasic study portal phase showed low-risk varices score 1 measures about 0.6 mm(black arrow image A). Endoscopy findings: grade 1 esophageal varices (white arrows, image B).

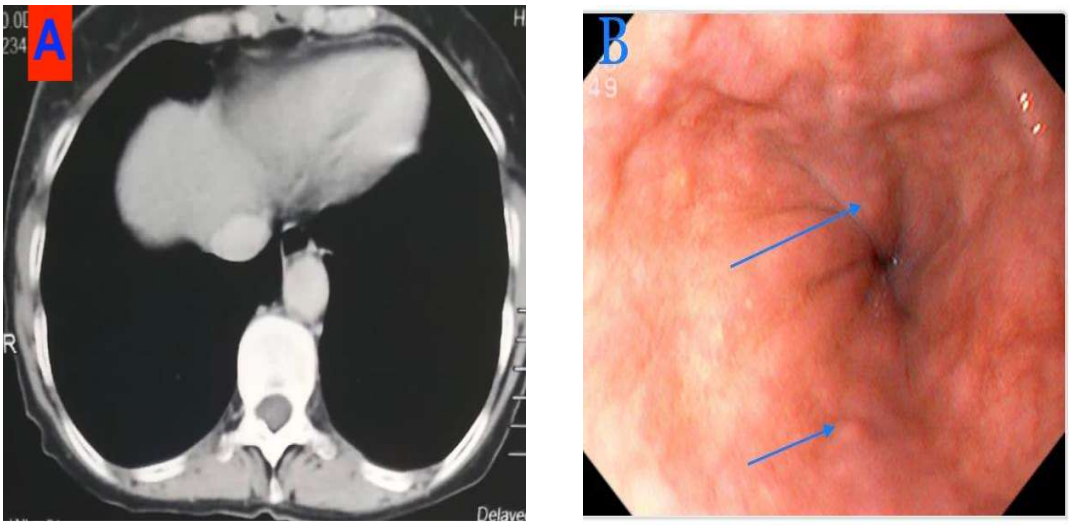

Figure 5. 48 years old female patient with known liver cirrhosis on routine endoscopic evaluation. CT: Triphasic CT portal phase of upper abdominal cuts shows normal esophageal lumen with no evidence of varices, score 1(image A). Edoscopy findings: grade 1 esophageal varices (image B).

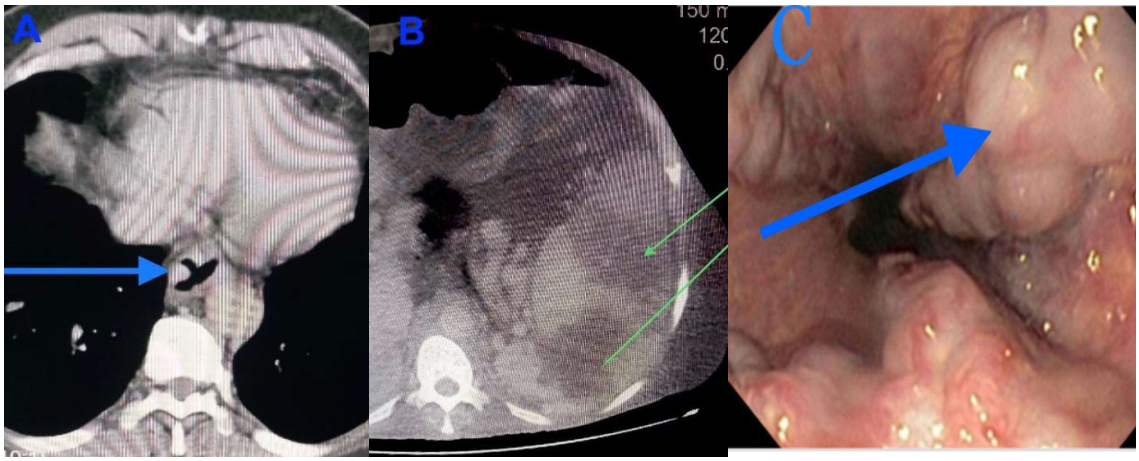

Figure 4 (A, B, C): 66 years old female patient with known liver cirrhosis presented with hematemesis. CT: Triphasic CT study portal phase of upper abdominal cuts portal phase shows few large well-defined high-risk varix score 4, the largest (blue arrow image A) measuring 7mm. Two large hypodense splenic focal lesions (green arrows in image B) were proven to be lymphoma as an accidental finding. Endoscopy findings: grade 3 esophageal varices(blue arrow image C).

Table 2. Agreement between CT and endoscopic risk scores:

CT		**Endo**			**Total**
		Negative	**low risk**	**high risk**	
Negative	Count	12 (TN)	0	0	12
	% within CT	83.3%	0.0%	0.0%	20%
	% within endo	100.0%	0.0%	0.0%	100.0%
low risk	Count	2 (FN as low risk)	4 (TP)	0	4
	% within CT	16.7%	66.3%	0.0%	6.6 %
	% within endo	9.1%	71.4%	0.0%	100.0%
high risk	Count	0	0	44 (TP)	44

	% within CT	0.0%	0.0%	100%	73.3%
	% within endo	0.0%	28.6%	100.0%	100.0%
Total	Count	10 (total N by endo)	6 (total P by endo)	44 (total P by endo)	60
	% within endo	16.6 %	10 %	73.4 %	100.0%
	% within CT	100.0%	100.0%	100.0%	100.0%
P-value		<0.001*			
Kappa		0.950			

*P-value is significant

For detecting esophageal varices and distinguishing between positive and negative cases when compared with the gold standard endoscopy, the overall sensitivity of MDCT was 96.0%, specificity 100.0%, positive predictive value (PPV) 100.0%, and negative predictive value (NPV) 80.0%. The overall diagnostic accuracy was 96.6%.

Table 3. Distribution of positive and negative cases among CT and upper endoscopes:

Diagnostic performance of CT	**True positive**	**True negative**	**False positive**	**False negative**	**Total**
	48	10	0	2	60
	Sensitivity (48/50)	Specificity (10/10)	PPV (50/50)	NPV (08/10)	Overall accuracy
	96.0%	100.0%	100%	80%	96.6%

MDCT-based risk stratification showed no significant association with age or sex, while splenomegaly was the only significant predictor of high-risk varices ($P < 0.001$). Other clinical and radiological findings were not significantly associated. (Table 4)

Table 4. Age, sex, clinical findings and co-findings distribution regarding the risk of varices by MDCT:

The risk of varices by MDCT	**Negative (n=12)**	**Low Risk (n=4)**	**High Risk (n=44)**	**P-value**
Sex				0.517
Male	9 (75%)	2 (50%)	28 (63.6%)	
Female	3 (25%)	2 (50%)	16 (36.4%)	
Age (mean ± SD)	51.9 ± 12	62.2 ± 14.8	59.1 ± 8.4	0.054
Hepatomegaly	8 (66.7%)	1 (25%)	34 (77.3%)	0.077
Portal vein thrombosis	1 (8.3%)	1 (25%)	11 (25%)	0.456
Splenomegaly	5 (41.7%)	4 (100%)	42 (100%)	**<0.001***
Ascites	3 (25%)	1 (25%)	9 (20.5%)	0.931
Hepatic focal lesions	5 (41.7%)	1 (25%)	26 (59.1%)	0.282

*P-value is significant

Discussion

Egypt reports the highest age-standardized mortality from complicated cirrhosis worldwide[15], which is primarily caused by hepatitis C virus infection.[16] This high disease burden underscores the need for accurate, non-invasive tools to detect and risk-stratify complications such as EVs. Herein, this study aimed to assess the efficacy of non-invasive MDCT in evaluating the EVs, in comparison with the gold standard EGD.

Concerning the prevalence of EVs among cirrhotic patients, in our study, EGD revealed that 16.6% of patients had no varices, 10% had low-risk varices, and 73.4% had high-risk varices, classified according to the Japanese 3-grade system[12] and the modified Paquet classification[13], with grades II and III considered high-risk. These results align with a prior study by Ali et al.[17], who reported that, based on EGD, 16% of cirrhotic patients had no EVs, while 84% had EVs, including 33.3% low-risk and 66.7% high-risk cases. Also, Deng et al.[18] mentioned that among 52 cirrhotic patients, the endoscopic examination showed that 13.5% had no EVs, 11.5% with mild varices, and 75% with moderate-to-severe varices. However, Moftah et al.[19] and El-Assaly et al.[20] demonstrated a different distribution of variceal grades, with a higher proportion of low-risk cases and fewer high-risk cases, compared to our cohort, where high-risk varices predominated. This discrepancy may reflect differences in patient selection, with our study including more advanced cirrhosis cases.

In the current work, using a 16-detector CT scanner with an optimized triphasic contrast-enhanced protocol, EVs were best visualized in the portal venous phase. The mean variceal diameter detected by CT was 4.4 ± 3.1 mm (range 0–12 mm). Applying a 4-point confidence scale with a >2 mm threshold for high-risk varices[14], MDCT identified

55% of patients as high-risk, 18.3% as probable high-risk, 6.6% as low-risk, and 20% without varices. Two cases of low-risk varices were missed, yielding an overall sensitivity of 96%, specificity of 100%, PPV of 100%, NPV of 80%, and diagnostic accuracy of 96%. Sensitivity for high-risk varices was 100%, compared with 80% for low-risk varices. False negatives were mainly related to small varices, which are more susceptible to hemodynamic and respiratory variations, and to difficulty in detecting minimally enhancing varices embedded within the esophageal wall. A strong agreement between MDCT and endoscopy was observed (kappa = 0.960, $p < 0.001$), supporting the reliability of MDCT in variceal assessment.

These findings indicate that MDCT demonstrated excellent diagnostic performance for detecting EVs and stratifying them into low-risk and high-risk categories in patients with liver cirrhosis. These findings are in close agreement with Moftah et al.[19], who reported comparable diagnostic performance, with 96% sensitivity, 100% specificity, and 100% PPV, although with a lower NPV (66.67%). Similarly, they found that MDCT sensitivity was higher for high-risk varices (100%) than for low-risk varices (94.12%). Likewise, Ali et al.[17] reported MDCT sensitivity of 92.8% and specificity of 100% for all EVs, with 100% sensitivity for high-risk varices. Mohamed et al.[11] observed similarly high diagnostic accuracy (99.5%) across all variceal grades. Hassan et al.[21] also reported high sensitivity, specificity and diagnostic accuracy for MDCT in detecting EVs in chronic liver disease patients (98.96%, 100%, and 98.97%, respectively). Our findings are also relatively comparable with those of Kumar et al.[22], who reported good diagnostic performance of CT virtual oesophagography in 62 cirrhotic patients, with sensitivity of 86%, specificity of 90%, PPV of 98%, NPV of 56%, and overall accuracy of 87%, along with a statistically significant agreement with endoscopy ($\kappa = 0.616$, $p \leq 0.001$). The authors concluded that CT-based techniques provide a reliable, non-invasive alternative for detecting EVs, with particularly strong performance in identifying clinically significant (high-risk) cases. However, the relatively lower reported NPV highlights the ongoing limitation of CT in excluding small or low-risk varices.

MDCT-based risk stratification in this study showed no significant association with age or sex, while splenomegaly was the only significant predictor of high-risk varices ($P < 0.001$). Other clinical and radiological findings were not significantly associated. In the same line, Moftah et al.[19] reported no significant association between variceal risk and age, sex, or extra-esophageal CT findings, which is largely consistent with our results, except for the significant association observed with splenomegaly in our cohort.

Despite these encouraging results, we faced many limitations during this study regarding MDCT. Small EVs may be difficult to detect due to hemodynamic variability, esophageal wall enhancement, or partial collapse, leading to reduced sensitivity for low-risk varices. MDCT cannot identify red signs, a key endoscopic predictor of bleeding. Other factors, such as hiatal hernia or distal esophageal thickening, may reduce measurement accuracy. The limited number of low-risk varices in our cohort, likely due to advanced cirrhosis and patient non-compliance, further constrained the assessment of smaller varices.

It is worth mentioning that MDCT esophagography is not only a reliable non-invasive alternative to conventional EGD for screening and risk stratification of esophageal varices in cirrhotic patients, but also offers additional clinical value. A triphasic abdominal CT allows simultaneous evaluation of hepatic focal lesions, assessment of portal hypertension, and detection of extra-esophageal findings. Therefore, MDCT provides a comprehensive, multi-purpose assessment, making it a more cost-effective initial imaging modality compared with upper endoscopy, which is limited to variceal detection and grading alone.

Conclusion

MDCT is highly accurate for detecting and grading high-risk EVs, with performance comparable to EGD. MDCT offers a non-invasive, objective, and reproducible alternative for variceal surveillance, particularly in patients with poor tolerance for endoscopy or advanced cirrhosis, and may reduce the need for routine invasive screening. This is particularly relevant in Egypt, where the high prevalence of HCV and cirrhosis underscores the need for accessible and accurate diagnostic tools.

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