Section: Radiodiagnosis

Original Research Article

MULTIDETECTOR CT PORTOGRAPHY AND ENDOSCOPY COMPARATIVE FOR ASSESSING GASTRO-ESOPHAGEAL VARICES IN PATIENTS WITH PORTAL HYPERTENSION

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ABSTRACT

Background: Portal hypertension, a major consequence of liver cirrhosis, frequently leads to the formation of gastroesophageal varices and portosystemic collateral pathways, posing significant risks of gastrointestinal hemorrhage. While endoscopy remains the gold standard for variceal detection, multidetector computed tomography (MDCT) offers a non-invasive alternative with comprehensive anatomical visualization. This study aimed to evaluate the diagnostic accuracy of MDCT portography in detecting and grading gastroesophageal varices and portosystemic collaterals, and to compare its findings with upper gastrointestinal (GI) endoscopy in patients with portal hypertension.

Materials and Methods: A prospective observational study was conducted on 50 patients with liver cirrhosis and clinically confirmed portal hypertension at Index Medical College, Indore, over 12 months. All patients underwent triphasic contrast-enhanced MDCT and upper GI endoscopy. Varices were classified and graded based on anatomical drainage and vessel diameter. Statistical correlations were assessed using SPSS v22.0.

Results: MDCT detected esophageal varices in 90% and gastric varices in 40% of patients, with a sensitivity of 94% and specificity of 83% and 90%, respectively. CT identified higher-grade gastric varices more effectively than endoscopy. A significant correlation was observed between CT variceal grade and hematemesis ($p = 0.001$). Collaterals were most frequently noted at the splenic hilum (86%). An inverse correlation existed between portal vein diameter and number of collaterals ($p = 0.02$), and a positive correlation with splenic vein diameter ($p = 0.002$).

Conclusion: MDCT is a highly effective, non-invasive imaging modality for comprehensive assessment of varices and collateral circulation in portal hypertension, with potential to supplement or replace diagnostic endoscopy in select clinical scenarios.

Keywords: Portal Hypertension, Multidetector CT (MDCT), Gastroesophageal Varices, Portosystemic Collaterals, CT Portography.

INTRODUCTION

Portal hypertension, commonly arising due to impeded portal venous blood flow as seen in liver cirrhosis, is a serious and progressive complication that contributes to significant morbidity and mortality.[1] One of its most critical manifestations includes the development of varices in the gastric fundus and esophagus, which pose a substantial risk of life-threatening upper gastrointestinal hemorrhage.[2] The approach to managing gastric varices (GV) is influenced by both their anatomical

location and underlying hemodynamic features. According to Sarin's classification—based on endoscopic findings—GV are categorized into distinct types depending on their localization.[3,4]

Variceal bleeding is a critical event, associated with a 6-week mortality approaching 20%. As a preventive strategy, individuals with cirrhosis or medium-to-large varices are routinely assessed for esophageal varices through upper gastrointestinal (GI) endoscopy. [5,6] Approximately 30% of these patients are found to have varices of ≥5 mm in diameter, which significantly increases the risk of bleeding.[7]

While endoscopy remains a key diagnostic tool, computed tomography (CT) imaging provides superior visualization of extravascular structures [8]. The advent of multidetector-row computed tomography (MDCT) has further improved diagnostic accuracy through enhanced spatial resolution and reduced motion artifacts, achieved by rapid image acquisition during a single breath-hold.[9]

Additionally, MDCT facilitates comprehensive three-dimensional (3D) post-processing, which aids in mapping the origin and distribution of porto-systemic collateral vessels in cirrhotic patients, making it an invaluable imaging modality in this context.[10] When coupled with 3D vascular reconstruction, MDCT angiography offers detailed visualization of variceal pathways, assisting surgeons in identifying high-risk vascular anomalies. This is particularly crucial not only for liver transplantation but also for other surgical interventions where unrecognized varices may lead to severe haemorrhage.[11]

This study aims to evaluate the diagnostic accuracy of MDCT portography compared to upper gastrointestinal (GI) endoscopy, which is considered the gold standard, in assessing gastro-esophageal varices in patients with portal hypertension. The findings could provide valuable insights into the potential role of MDCT in clinical practice, particularly for non-invasive variceal evaluation.

MATERIALS AND METHODS

After approval from institutional ethical committee, this prospective observational study was conducted in the Department of Radiology at Index Medical College Hospital & Research Centre, Indore for a duration of 12 months i.e., from October 2023 to September 2024. A total of 50 patients clinically and radiologically diagnosed with liver cirrhosis and portal hypertension were enrolled. Eligible participants were adults aged 18 years or older, with a confirmed diagnosis of portal hypertension and fit to undergo upper gastrointestinal (GI) endoscopy. Written informed consent was taken from all patients after full explanation of the procedure and objectives.

Inclusion Criteria

1. Age ≥ 18 years
2. Diagnosis of liver cirrhosis
3. Presence of portal hypertension
4. Clinical suitability for upper GI endoscopy

Exclusion Criteria

1. Non-consenting individuals
2. Patients with impaired renal function (serum creatinine > 1.5 mg/dL)

Methodology

A detailed clinical assessment was undertaken for each patient, recording demographic data (age, sex), presenting symptoms (hematemesis, melena, ascites), and relevant medical history. Physical examination findings were noted. Laboratory investigations included liver function tests (SGOT, SGPT), hepatitis serologies (HBsAg, anti-HCV by ELISA), and renal function tests to ensure eligibility.

All patients underwent both contrast-enhanced multidetector computed tomography (MDCT) and upper GI endoscopy. MDCT portography was performed using a four-phase protocol—non-contrast, arterial, portal venous, and delayed phases—with CT angiography to visualize vascular anatomy in detail. Three-dimensional reconstructions were employed for enhanced assessment of varices and portosystemic collaterals.

Classification and Grading of Varices:

Varices were classified according to their drainage into either the superior vena cava (SVC) or inferior vena cava (IVC). SVC-draining varices included esophageal, paraesophageal, and gastric types, while IVC-draining varices included splenic, perisplenic, lienorenal, and recanalized paraumbilical varices.

Based on anatomical location, gastric varices were further categorized as submucosal or adventitial. Veins >3 mm from splenic or paraumbilical systems and >2 mm from esophageal or gastric regions were considered significant. Varices were graded on a 5-point scale using diameter and number of dilated vessels, with grades raised one level if more than four vessels appeared on a single transverse image. Grading criteria are detailed in Table 1.

Table 1: Grading of Varices Based on Largest Diameter,[12]

Varices	Grade	Largest Diameter of Varices (mm)
Esophageal, paraesophageal, and gastric submucosal varices	0	< 2
	1	2–2.9
	2	3–6.9
	3	≥ 7
	4[a]	≥ 7
Gastric adventitial, splenic, mesenteric, retroperitoneal varices	0	< 3
	1	3–4.9

	2	5–9.9
	3	≥ 10
	4[a]	≥ 10

Note: If the number of dilated vessels seen on transverse images exceeds four, the grade is increased by one level; [a]Grade 4 is assigned when the number of Grade 3 varices exceeds four.

Data Collection and Statistical Analysis:

All relevant clinical, laboratory, endoscopic, and radiological findings were documented using a structured pre-designed proforma. Statistical analysis was carried out using SPSS version 22.0. Descriptive statistics (mean, standard deviation, and percentages) were used to summarize the data. Comparative analyses were conducted using the Mann-Whitney test, and correlation was assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant, while p < 0.001 was considered highly significant.

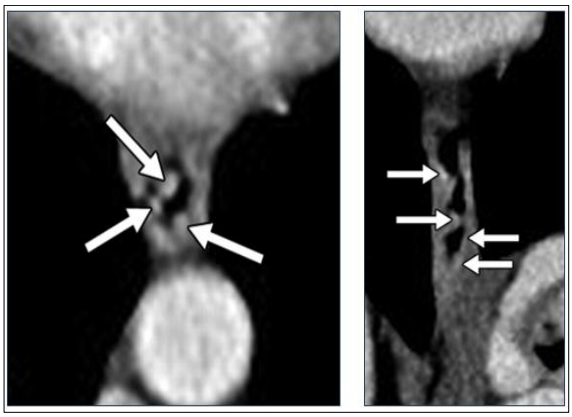

Figure 1: 27-year-old woman with Liver left lobe hypertrophy and portal hypertension showing grade 1 esophageal varices. Portal venous phase CT images in axial and coronal plane show multiple enhancing columns

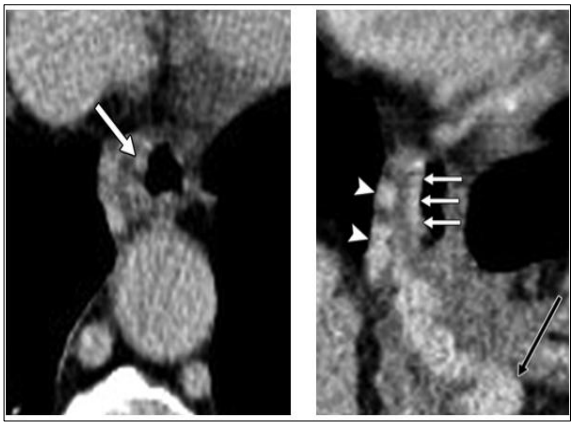

Figure 2: 48-year-old man with cirrhosis and grade 2 esophageal varices. Axial and Coronal image shows enlarged left gastric vein (black arrow) with collaterals extending up to paraesophageal varices (arrowheads)

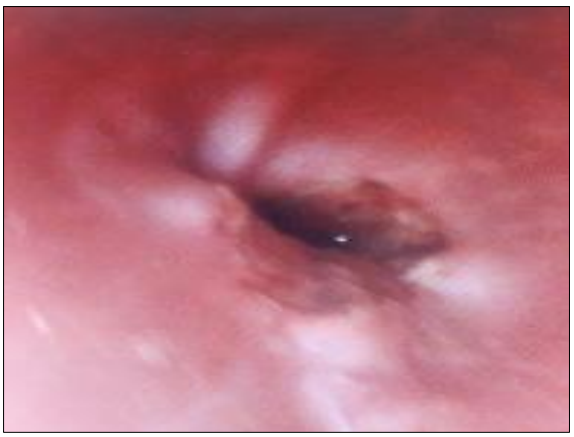

Figure 3: Endoscopy image shows minimally protruding, small varices with Erythema.

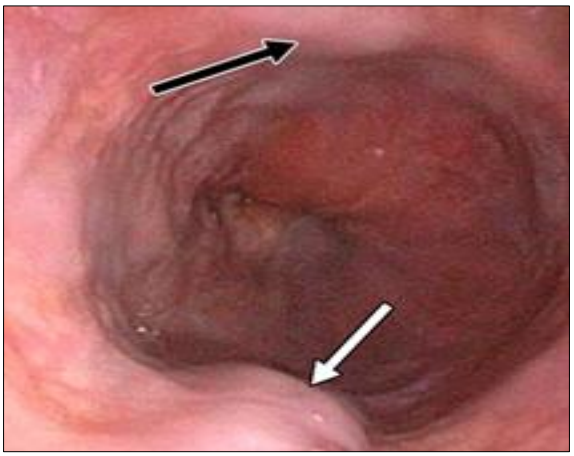

Figure 4: Endoscopy image shows one medium-sized varix (white arrow) along with at least one other small varix (black arrow)

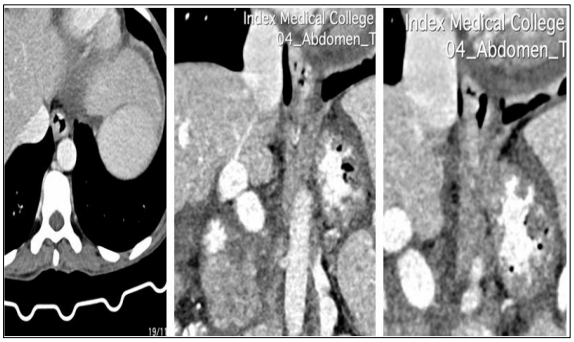

Figure 5: 54-year-old man with cirrhosis and grade 3 esophageal varices. CT images in both axial and coronal planes varices with nearly circumferential involvement

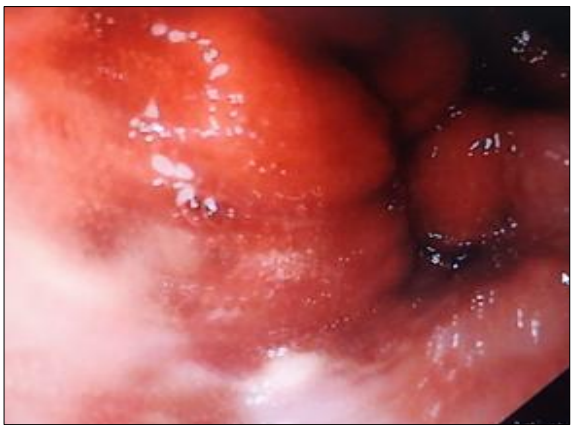

Figure 6: Endoscopy image shows confluence of large and tortuous varices

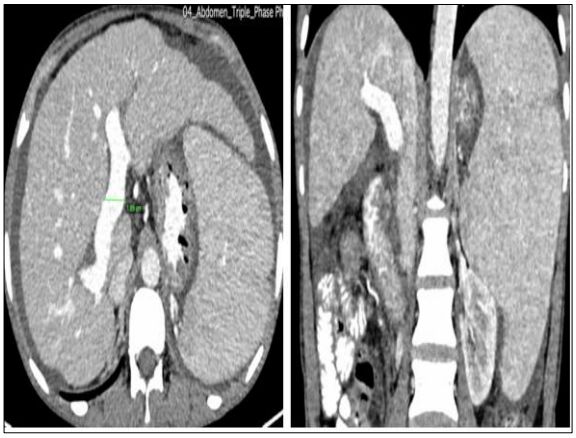

Figure 7: A 47-yr female presented with cirrhosis shows Portal vein dilatation measuring approx 18 mm

Figure 8: Reconstruction of Collaterals

RESULTS

This study assessed a total of 50 patients diagnosed with portal hypertension, including 23 males and 27 females. The age of the study population ranged from 41 to 67 years, with a mean age of 55.1 ± 6.33 years. Regarding the clinical presentation, hematemesis was a common finding among the participants. Specifically, 34% of patients reported experiencing a single episode of hematemesis, while 40% had recurrent episodes. In contrast, 26% of the patients had no history of hematemesis. [Figure 10]

Evaluation of portal vein patency revealed that the majority of patients (84%) had a patent portal vein, whereas 16% demonstrated portal vein thrombosis. In terms of portal vein diameter, 44% of the patients exhibited dilated portal veins, while the remaining 56% had normal-caliber portal veins. {Figure 11] These findings highlight the prevalence of both bleeding complications and vascular changes in patients with portal hypertension, emphasizing the need for comprehensive imaging and clinical correlation in their evaluation.

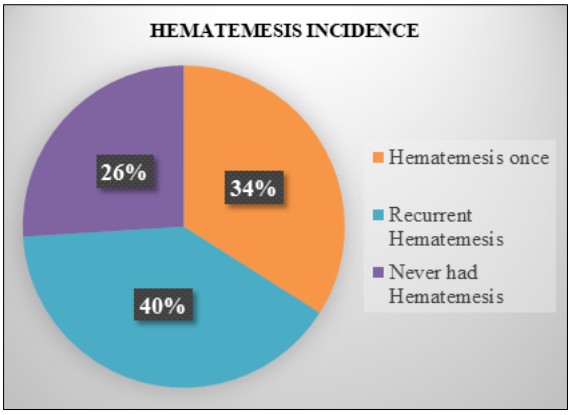

Figure 9: Distribution of Study Participants based on Incidence of hematemesis

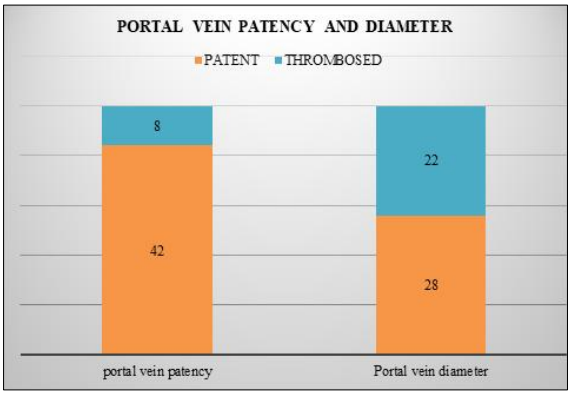

Figure 10: Distribution of Study Participants based on Portal vein patency and diameter

In this study, esophageal varices were detected in a majority of patients using both multidetector computed tomography (MDCT) and upper gastrointestinal (GI) endoscopy. CT imaging identified esophageal varices in 45 out of 50 patients (90%), while endoscopy—considered the gold standard—detected varices in 48 patients (96%). The sensitivity of CT in detecting esophageal varices was calculated to be 94%, indicating its high diagnostic value.

On grading analysis, CT identified 18 patients each with Grade I and Grade II varices, and 9 patients with Grade III varices. No Grade IV varices were observed on CT. Endoscopic evaluation showed a similar distribution, with 20 cases of Grade I, 13 cases of Grade II, and 5 cases of Grade III varices; again, no cases of Grade IV varices were reported. Although minor discrepancies were noted in grading

between modalities, the overall diagnostic concordance was high. [Table 2]

Table 2: Comparison of Esophageal Varices Grading by CT and Endoscopy

Grade	CT Findings (N = 45)	Endoscopy Findings (N = 48)
Grade I	18	20
Grade II	18	13
Grade III	9	5
Grade IV	0	0
Total	45 (90%)	48 (96%)

Importantly, a statistically significant correlation was observed between the grade of esophageal varices on CT and the occurrence of hematemesis ($p = 0.001$). Patients with higher-grade esophageal varices were more likely to experience episodes of hematemesis, emphasizing the clinical relevance of accurate variceal grading via imaging in the management and risk stratification of portal hypertension. [Table 3]

Table 3: Correlation Between CT Grade of Esophageal Varices and Hematemesis

CT Grade of Esophageal Varices	Hematemesis Incidence
Grade I	Mild or no hematemesis
Grade II	Intermittent or single episode
Grade III	Frequent or recurrent episodes
Statistical Correlation	p = 0.001 (Highly significant)

This study highlights the effectiveness of multidetector CT (MDCT) in evaluating esophageal and gastric varices in patients with portal hypertension. CT detected esophageal varices in 90% of patients, closely aligning with endoscopic findings (96%), and showed a sensitivity of 94% and specificity of 83%. For gastric varices, CT identified more cases (20 patients) compared to endoscopy (12 patients), with a specificity of 90%, underscoring CT's superior capability in detecting extraluminal varices such as paraesophageal and retro-gastric varices, which are often missed on endoscopy. Grading discrepancies were noted, with CT detecting 8 cases of Grade IV gastric varices not seen on endoscopy. This suggests CT is more sensitive in identifying deeper or adventitial varices. [Table 4]

Table 4: Grading of Gastric Varices by CT vs. Endoscopy

Grade	CT Findings (N = 20)	Endoscopy Findings (N = 12)
Grade I	2	8
Grade II	5	2
Grade III	5	2
Grade IV	8	0

Portosystemic collateral pathways were most frequently identified at the splenic hilum and perisplenic region, observed in 86% of patients, followed by coronary collaterals (50%) and splenorenal shunts (26%). This distribution underscores the predominance of splenic-based decompressive pathways in portal hypertension. A statistically significant inverse correlation was observed between portal vein (PV) diameter and the number of collaterals ($p = 0.02$), indicating that an increase in collateral formation is associated with a reduction in PV diameter, likely due to diversion of blood flow through alternative venous pathways. Additionally, a strong positive correlation was found between PV diameter and splenic vein diameter ($p = 0.002$), reflecting the hemodynamic interdependence of these vessels in the portal system. However, there was no significant correlation between PV thrombosis and collateral number ($p > 0.05$), suggesting that collateral development is more strongly influenced by chronic pressure dynamics than by thrombotic events.

Table 5: Frequency of Portosystemic Collaterals

Collateral Type	No. of Patients (N = 50)	Percentage (%)
Splenic hilum/perisplenic	43	86%
Coronary	25	50%
Splenorenal	13	26%
Retroperitoneal	7	14%
Paraumbilical vein	5	10%
Mesenteric	4	8%
Gastrorenal	3	6%
Abdominal wall	2	4%
Intrahepatic	1	2%
Duodenal	1	2%

The specificity of MDCT in identifying varices was notably high, with 83% specificity for esophageal varices and 90% for gastric varices, reinforcing its diagnostic reliability. These findings affirm MDCT as a robust non-invasive imaging tool capable of providing both anatomical and functional insights into the portal circulation. In clinical practice, MDCT not only complements endoscopic evaluation

but may also serve as an alternative in cases where endoscopy is contraindicated or incomplete, particularly for the detection of extraluminal collaterals and high-risk varices.

DISCUSSION

Multislice CT, particularly with triphasic protocol and MIP (Maximum Intensity Projection) reconstruction, has emerged as a vital imaging modality in the evaluation of portal hypertension. It enables comprehensive visualization of portosystemic collateral pathways, variceal grading, and associated complications such as portal vein thrombosis and hepatocellular carcinoma (HCC). In this study, 50 patients with clinically and radiologically confirmed portal hypertension secondary to liver cirrhosis were evaluated using triphasic CT portography. The results underscore the diagnostic power of CT in detecting gastroesophageal varices and related collateral circulations, aligning closely with previous findings by Wang et al,[13] who emphasized CT MIP portography as an effective, non-invasive tool for assessing compensatory vascular changes in decompensated portal hypertension.

While our findings support the use of CT as a frontline imaging technique, Agrawal SK et al. viewed CT as a secondary modality, recommending ultrasonography with color Doppler as the initial imaging investigation.[14] Contrary to this viewpoint, our study demonstrated that CT was not only effective in identifying all types of collaterals but also offered superior anatomical detail and grading accuracy, especially for extraluminal varices not seen on endoscopy.

Radiologically, splenomegaly was observed in 98% of our cases and portal vein thrombosis in 18%, which is notably higher than the 85% and 5% reported by Agrawal SK et al., respectively.[14] This variation may reflect differences in study populations, disease severity, or imaging sensitivity. Among collaterals draining into the superior vena cava, perigastric varices were most frequently observed, consistent with Hesenler et al.[15] Regarding inferior vena cava drainage, splenic collaterals were the most common in our cohort (56%), followed by recanalized paraumbilical veins (10%), which aligns well with the findings of El Wakeel et al.[4]

Gastric fundic varices were detected in 96% of patients using CT, whereas esophageal varices were visualized in only 8% of cases. This sharply contrasts with Hesenler et al,[15] who reported 90% esophageal and only 34% gastric varices, possibly due to differences in underlying etiologies or imaging methodology. Our results closely mirror those of Wang et al., who identified gastric varices in 97% and esophageal varices in 83% of patients, further supporting the reliability of CT in detecting fundal collaterals.[8] Agarwal et al,[8] also reported similar collateral patterns, identifying esophageal, left gastric, and short gastric vein collaterals in 6%, 13%, and 5% of cases, respectively.

In terms of variceal grading based on CT, 40% of esophageal varices were Grade I, another 40% Grade II, and 20% Grade III. No cases of Grade IV esophageal varices were observed. For gastric varices, 10% were Grade I, 25% each in Grades II and III, and 40% were Grade IV. This distribution highlights CT's ability to detect higher-grade gastric varices more effectively than endoscopy. Our findings corroborate those of Yu NC et al,[16] and El Wakeel et al,[4] who noted that endoscopic undergrading of high-risk varices could falsely elevate CT's sensitivity for detecting low-risk cases. This emphasizes the importance of CT as a grading tool, particularly when endoscopic evaluation is inconclusive or contraindicated.

Furthermore, the role of CT in reducing unnecessary invasive procedures is gaining recognition. Kim et al,[17] advocated for the use of liver MDCT as a non-invasive surveillance tool for both high-risk varices and recurrent HCC, potentially obviating routine endoscopic surveillance in selected cases. Similarly, Perri et al,[18] and Boregowda U et al,[6] emphasized CT's high sensitivity in identifying gastric and high-risk esophageal varices, some of which were missed on endoscopy, reinforcing CT's role in clinical decision-making.

This study also demonstrated significant statistical correlations. An inverse correlation between portal vein diameter and the number of collaterals ($p = 0.001$) suggests that as portal pressure increases and collaterals develop, the portal vein diameter diminishes due to compensatory diversion of blood flow. A strong positive correlation was also found between portal vein and splenic vein diameters ($p < 0.001$), indicating synchronous hemodynamic changes in the portal circulation. These findings are consistent with the pathophysiological basis of portal hypertension and support the use of CT metrics in risk stratification and treatment planning.

In summary, the results from our study underscore the indispensable role of multislice CT in the non-invasive assessment of portal hypertension. It not only facilitates accurate detection and grading of varices but also provides vital information on collateral circulation, portal vein patency, and associated complications, thereby enhancing diagnostic confidence and guiding therapeutic strategies.

CONCLUSION

Multi-slice CT has proven to be an essential non-invasive imaging modality in the evaluation of portal hypertension, particularly for detecting portosystemic collaterals, grading varices, and identifying complications such as portal vein thrombosis. The findings of this study reinforce the

diagnostic value of CT portography, which in many cases may serve as an effective alternative to diagnostic endoscopy, especially for identifying high-risk varices and extraluminal collaterals that endoscopy cannot visualize. Furthermore, the statistically significant correlations observed between portal vein diameter, splenic vein diameter, and the number of collaterals underscore CT's role in providing comprehensive anatomical and hemodynamic assessment. Thus, CT not only complements endoscopic evaluation but also enhances diagnostic confidence and facilitates optimal management in patients with portal hypertension.

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