Original Article

Duplex Ultrasound Evaluation of Portal Vein Diameter as a Predictor of Esophageal Varices: A Cross-Sectional Study

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Abstract:

Background: Portal hypertension is directly related to esophageal varices, a common side effect of liver cirrhosis. Given the high mortality rate of life-threatening variceal hemorrhage, early detection is essential. Despite being the gold standard for diagnosing varices, endoscopy's invasiveness and scarcity underscore the need for trustworthy non-invasive substitutes. One method that has shown promise in the prediction of esophageal varices is duplex ultrasound, specifically the measurement of portal vein diameter. **Objective:** The purpose of this study was to evaluate the diagnostic precision of portal vein diameter, as determined by duplex ultrasound, in identifying esophageal varices in patients with cirrhosis. **Methods:** A cross-sectional study with 58 liver cirrhosis patients was carried out in the department of Radiology & Imaging, Dhaka Medical College, Dhaka, from July 2021 to June 2023. Both outpatient department or indoor patients were included. Portal vein diameter was measured using duplex ultrasound; a value of >13 mm is thought to be a predictive threshold for esophageal varices. Statistical analyses of the result were obtained by using window-based Microsoft Excel and Statistical Package for Social Sciences (SPSS-24). **Results:** Excellent diagnostic accuracy was shown by portal vein diameter >13 mm, with a sensitivity of 94.87%, specificity of 73.68%, PPV of 88.10%, NPV of 87.50%, and overall accuracy of 87.93%. 95% CI: 0.827–0.993, $p < 0.001$, and the AUC was 0.874. Of the 39 patients who had varices confirmed by endoscopy, 37 were properly identified, and two were overlooked. Fourteen of the 19 patients without varices were correctly ruled out, while 5 were false positives. **Conclusion:** A very useful non-invasive marker for esophageal varices, portal vein diameter as determined by duplex ultrasound holds great promise in settings with limited resources.

Keywords: Portal vein diameter, Duplex ultrasound, Esophageal varices, Portal hypertension.

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Introduction:

Portal hypertension and esophageal varices are among the complications that can arise from liver cirrhosis, a progressive disease marked by fibrosis and structural alterations in the liver[1]. These varices are a significant cause of morbidity and mortality because they can result in potentially fatal hemorrhage. They are present in 50–60% of patients with compensated cirrhosis and up to 80% of patients with decompensated cirrhosis[2,3]. A six-week mortality rate of up to 25% per bleeding episode is associated with variceal hemorrhage, which has an annual risk of 5% to 15%[4]. In order to prevent variceal bleeding with prompt interventions like beta-blockers or endoscopic variceal ligation, screening for esophageal varices is essential.

Even though upper gastrointestinal endoscopy is the gold standard for identifying varices, non-invasive diagnostic alternatives are being sought after due to its invasiveness, expense, and restricted accessibility in settings with limited resources[5,6,7]. Although they have demonstrated promise, non-invasive techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and liver stiffness measurement are frequently expensive and not accessible in all healthcare settings[8–10].

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The role of duplex ultrasound, a commonly available non-invasive technique, in evaluating portal hypertension and its complications has been thoroughly investigated[11–14]. Because of the hemodynamic alterations brought on by elevated portal pressure, portal vein diameter has become one of its key predictors of esophageal varices[15–18]. An enlarged portal vein diameter is a useful screening metric, especially in low-resource settings, as studies have shown a strong correlation between it and the presence of esophageal varices[19–22]. This study assesses the diagnostic precision of duplex ultrasound measurements of portal vein diameter in identifying esophageal varices. This study intends to establish portal vein diameter as a trustworthy, non-invasive method for early identification of patients at risk of variceal hemorrhage by evaluating sensitivity, specificity, and predictive values. This will ultimately improve clinical outcomes and lessen the need for invasive procedures.

Methods:

Research Design: In order to assess the diagnostic precision of duplex ultrasound measurements of the portal vein diameter in anticipating esophageal varices, this study was cross-sectional. The efficacy of this non-invasive method in liver cirrhosis patients was assessed by analyzing sensitivity, specificity, and overall performance.

Place of Study: The study was conducted in the Department of Radiology and Imaging, Dhaka Medical College Hospital, Dhaka, Bangladesh. **Period of Study:** The research took place over two years, from July 2021 to June 2023.

Study Population: Patients with liver cirrhosis who were diagnosed and seen in the Dhaka Medical College Hospital's outpatient and inpatient departments were included. The study included patients who were referred to the Department of Radiology and Imaging for additional imaging tests. **Sampling Technique:** Adult patients with clinically diagnosed liver cirrhosis were chosen through the use of purposive sampling. These patients were being regularly screened for esophageal varices. The clinical history, physical examination, liver function tests, and preliminary ultrasound results were used to make the selection. After determining the necessary sample size, 58 participants in total were included. This sampling technique made sure that the evaluation of the diagnostic accuracy of duplex ultrasound in this situation was targeted and included pertinent cases. **Data Analysis:** SPSS version 26.0 was used to analyze the data. Clinical and demographic features were summed up using descriptive statistics. Using sensitivity, specificity, PPV, NPV, accuracy, and AUC, the diagnostic accuracy of duplex ultrasound in predicting esophageal varices (portal vein diameter >13 mm) was evaluated. 95% confidence intervals were included, and $p < 0.05$ was the threshold for statistical significance. **Ethical approval:** The ethical clearance was taken from the ethical review committee of Dhaka Medical College, the ethical clearance no: ERC-DMC/ECC/2021/268 R.

Results:

Table 1 shows the diagnostic accuracy metrics for predicting esophageal varices based on portal vein diameter (>13 mm). The parameter's sensitivity of 94.87% (95% CI: 90.3–97.2, $p < 0.001$) shows that it consistently detects most true cases while reducing false negatives. With a specificity of 73.68% (95% CI: 62.5–81.9, $p < 0.001$), it can identify cases without variations with a moderate degree of accuracy. A high probability of negative results is indicated by the negative predictive value (NPV) of 87.50% (95% CI: 77.6–93.1, $p < 0.001$), whereas the positive predictive value (PPV) of 88.10% (95% CI: 80.5–92.3, $p < 0.001$) indicates that the majority of patients who are classified as positive actually have esophageal varices. The parameter's overall accuracy of 87.93% (95% CI: 78.5–94.2, $p < 0.001$) demonstrates its dependability in differentiating between positive and negative cases. Last but not least, the area under the curve (AUC) of 0.874 (95% CI: 0.827–0.993, $p < 0.001$) validates portal vein diameter as a strong non-invasive predictor for esophageal varices and confirms excellent discriminatory ability.

Table-I: Diagnostic Accuracy of Portal Vein Diameter (>13 mm) for Predicting Esophageal Varices

Parameter	Value	95% CI	p-value
Sensitivity (%)	94.87	90.3–97.2	<0.001
Specificity (%)	73.68	62.5–81.9	<0.001
Positive Predictive Value (PPV) (%)	88.10	80.5–92.3	<0.001
Negative Predictive Value (NPV) (%)	87.50	77.6–93.1	<0.001
Accuracy (%)	87.93	78.5–94.2	<0.001
Area Under the Curve (AUC)	0.874	0.827–0.993	<0.001

The ability of portal vein diameter (>13 mm) to diagnose esophageal varices is demonstrated in table 2. With a high sensitivity of 94.87%, 37 of the 39 patients with esophageal varices confirmed by endoscopy were correctly identified (true positives), while only 2 cases

were overlooked (false negatives). The test's specificity was 73.68% among the 19 patients without varices, with 14 correctly receiving a negative diagnosis (true negatives) and 5 receiving a false positive diagnosis. These findings suggest that a portal vein diameter greater than 13 mm is very useful for identifying actual esophageal varices with few missed diagnoses. But in suspected cases, the existence of false positives emphasizes the necessity of confirmatory endoscopy. All things considered; this metric is a trustworthy non-invasive screening method that is especially helpful in clinical settings for identifying patients who may be at risk for esophageal varices.

Table-II: Duplex Sonographic Prediction of Portal Vein Diameter (>13 mm) Compared with Endoscopic Findings

Portal Vein Diameter (>13 mm)	Endoscopy Positive	Endoscopy Negative	Total
Positive (≥13 mm)	37 (True Positives)	5 (False Positives)	42
Negative (<13 mm)	2 (False Negatives)	14 (True Negatives)	16
Total	39	19	58

Discussion:

This study shows how portal vein diameter, as determined by duplex ultrasound, can be used to diagnose liver cirrhosis patients and predict esophageal varices. According to the results, a portal vein diameter greater than 13 mm has a high sensitivity (94.87%) and accuracy (87.93%), which makes it a great screening tool for dangerous patients. These findings are consistent with earlier studies showing that portal vein diameter signifies elevated portal pressure, which is a defining feature of portal hypertension and esophageal variceal development[1,17,20]. The moderate specificity (73.68%) raises the possibility of false-positive test results. This is in line with research demonstrating that cirrhotic patients without clinically significant varices may experience structural alterations in the portal venous system[11,16]. These results emphasize the necessity of a follow-up endoscopic examination, especially in cases that are borderline.

As a diagnostic marker, portal vein diameter's discriminatory power is further supported by its high AUC (0.874). Non-invasive techniques like Doppler ultrasonography have shown comparable AUC values in comparable studies, confirming their use in resource-constrained environments for varices screening[12,23]. The high positive predictive value (88.10%) and negative predictive value (87.50%) of this study also concur with earlier research showing the accuracy of ultrasound parameters in determining the presence or absence of esophageal varices[20,24].

Elevated portal venous pressure, which results in vascular remodeling and portal vein dilatation, is the pathophysiology behind these findings. Portal vein diameter and other Doppler parameters are trustworthy stand-ins for measuring portal hypertension, a major factor in variceal formation, according to studies by Li et al. and Moriyasu et al. Although duplex ultrasound is a non-invasive and easily accessible method, its moderate specificity emphasizes that it should be used in conjunction with endoscopy rather than as a substitute. For instance, when paired with portal vein diameter, Doppler-derived indices like the congestion index may increase the accuracy of the diagnosis[25,26]. For better identification of patients at high risk of variceal hemorrhage, this combined approach has been suggested[13,27]. Lastly, the study population's demographic profile, which is primarily middle-aged men, is consistent with established epidemiological patterns in liver cirrhosis, where alcohol consumption and viral hepatitis are major risk factors[2,5,6]. These high-risk groups can benefit from targeted interventions that maximize early detection and management.

Conclusion:

The findings highlight that a dependable, non-invasive indicator for esophageal varices prediction is portal vein diameter >13 mm as determined by duplex ultrasound. It should, however, be used as part of a more comprehensive diagnostic approach due to its moderate specificity, especially in settings with limited resources where endoscopy is not easily accessible. To further improve diagnostic accuracy, future research should investigate combining biochemical markers with ultrasound parameters.

Limitations of the study:

The current study was conducted in a very short period due to the time constraints and funding limitations. The small sample size was also a limitation of the study.

Recommendation:

The inclusion of portal vein diameter in standard screening procedures is supported, particularly in settings with limited resources where endoscopy may not be easily accessible. For increased accuracy, future studies should look into combining duplex ultrasound with additional markers.

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