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Correlation between Portal Vein Diameter and Esophageal Varices Grades in Chronic Liver Disease Patients using Ultrasonography and Endoscopy as a Diagnostic Tool

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ABSTRACT

Background: Chronic liver disease accounts for 2.2% of deaths and 1.5% of disability-adjusted life years. Variceal bleeding is one of the preventable caused of death in chronic liver disease. About 30-40% of patients with compensated cirrhosis and 85% of those with decompensated cirrhosis are found to possess EV on screening endoscopy.

Objective: To determine the correlation between Portal Vein Diameter (PVD) on ultrasound examination and grades of Esophageal Varices (EV) on endoscopy in patients with Chronic liver disease (CLD).

Material and Methods: This was a cross-sectional, correlational study, carried out in the Department of Diagnostic Radiology in collaboration with the Department of Gastroenterology, at Lady Reading Hospital Peshawar, Pakistan. Atotal of sixty patients were sampled via consecutive random sampling from Jan 2022 to Sept 2022. The criteria used for dilated portal vein was = 13mm and = 13 cm for splenomegaly.

Results: Out of total 60 patients with CLD, PVD ranged from 10 to 18mm, mean PVD being 14.1mm ±1.4. The splenic sizes ranged from 10 to 23 cm, with the mean splenic cranio-caudal dimension being 14.9 cm ± 2.1. The highest association is between the large EV and PVD > 15 mm i.e., 52% of total large EVs. The differences between PVD to EV groups were statistically significant as determined by one-way ANOVA (F (2,57) =8.281, p= 0.001) and correlation was also statistically significant on Pearson's Correlation test (rs)[60] = 0.490, p < 0.001.

Conclusion: As there is a significant positive correlation between PVD and grades of EV in CLD patients. The PVD on ultrasound should be utilized where an endoscopic facility is not available, or is overburdened, to prevent life threatening esophageal variceal bleed.

Keywords: Chronic liver disease, Esophageal varices, Portal vein diameter.

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INTRODUCTION

Chronic liver disease (CLD) is characterized by decreased hepatic function. It can progress through stages of fibrosis to end-stage disease "Cirrhosis", which accounts for 2.2% of deaths and 1.5% of disability-adjusted life years according to statistics of 2016.[1] It ranks eighth in economic cost among the major illnesses.[2]There are multiple etiological factors for CLD, the commonest being alcohol, non-alcoholic steatohepatitis, Chronic viral hepatitis, genetic and auto-immune diseases, and drugs. Chronic hepatitis B, C, and D infections are the most commoncauses of CLD in East Asia and Sub-Saharan Africa.[3] The World Health Organization (WHO) estimated that during 2019, 296 million people worldwide were living with hepatitis B and 58 million living with hepatitis C.[4]Chronic hepatitis C has a worldwide prevalence of almost 1.2% - 1.7% of the global population.[5] According to the recent estimates of the Task Force for Global Health, Pakistan might rank the highest globally when it comes to Hepatitis B and C burden. The national prevalence of HBV in Pakistan was 2.5% in 2008. From 2015 to 2019, there was a 5% increase in HCV-related deaths and an 8% increase in HBV-related deaths. [6]

The diagnosis of cirrhosis is based on clinical features and biochemical and radiological parameters. The radiological findings are nodular liver and signs of portal hypertension,[7] which include, portal vein dilatation, splenomegaly, portosystemic collaterals including esophageal varices (EV), and ascites. About 30-40% of patients with compensated cirrhosis and 85% of those with decompensated cirrhosis are found to possess EV on screening endoscopy.[8]

The rate of development of new varices and increase in grades of varices is 8% per year. An increase in the size of varices leads to an increase in wall tension to a critical level at which they rupture, thereforethe size of the EV is a predictor of hemorrhage and mortality.[9]

The majority of subjects undergoing screening endoscopy either do not have varices or have varices that can be managed conservatively with Propranolol.[10] Additionally, many patients refuse to undergo endoscopy due to the unpleasant and

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invasive nature of the procedure. In developing countries, there is also a lack of advanced healthcare resources in most areas. This led to the need for a more cost-effective, easily available, and non-invasive method to routinely screen patients with CLD.[8] The ultrasound assessment of portal vein size is a simple cost-effective non-invasive predictor for the presence and size of EV, available in most healthcare facilities even in developing countries.[11]

The purpose of our study is to assess the correlation of portal vein diameter (PVD) and grades of EV in CLD patients to utilise ultrasound to detect and monitor disease progression for better patient management.

MATERIALS AND METHOD

This was a cross-sectional, correlational study, carried out in the Department of Diagnostic Radiology in collaboration with the Department of Gastroenterology, at Lady Reading Hospital Peshawar, after ethical approval by Institutional Ethical Review Board (Reference number 357/LRH/MTI, Dated: 11.5.2022). All patients with liver cirrhosis, regardless of the aetiology, who were found to have EV on endoscopy, were included in the study. Patients attending outdoor and emergency departments or admitted as inpatients, from Jan 2022 to Sept 2022, were included. Patients with known bleeding disorders, no EV, prior variceal ligation, hepatic mass, portal vein thrombosis, and splenectomy were excluded from the study. A total of sixty patients were sampled using non probability convenient sampling. The minimum Sample size was 58 as calculated using WHO calculator for correlation with the assumptions: 8% yearly incidence of esophageal varices,[8] Significance level= 7%, confidence level 95% and Statistical power 80%. We followed STROBE guidelines to report this cross sectional observation study.

Written informed consent was taken from all patients for inclusion in the study. Ultrasonography was performed by a consultant radiologist by placing the patient in the supine position and during full inspiration. Assessment of the liver parenchyma, portal vein diameter(PVD) and its patency, splenic size, and absence or presence of ascites was noted. Mindray DC-70 machine B-mode imaging with a 3.5 MHz curved array transducer was utilized. The criteria used for dilated portal vein was = 13 mm measured where the portal vein crosses anterior to the IVC. Ultrasound assessment of PVD were grouped into four categories,[12] that is less than 13 mm, 13 to 13.9mm, 14 to 14.9mm, and more than 15mm in diameter. A splenic cranio-caudal measurement of = 13 cm was taken as enlargement.

Operational Definitions

Portal vein diameter: The diameter of portal vein measured with the patient in the right anterior oblique position, at the broadest point of PV where it crosses the IVC.

Esophageal varices: Dilated submucosal veins of the esophagus which are an important portosystemic collateral pathway.[4]

Endoscopy: Medical examination of the interior of the GI system by the insertion of a flexible, lighted optical shaft or open tube through oral route.[12]

The endoscopy was performed by a gastroenterologist and the Grading of varices was done on basis of the classification proposed by the North Italian Endoscopic Club. This classification uses the proportion of the radius of the esophagus occupied by the largest varix at full insufflation. The grades are; small varices (minimally elevated above the oesophageal mucosa that typically flatten with air insufflation), medium varices (occupying less than one-third of the oesophageal lumen and do not flatten with insufflation), and large varices (occupying greater than one-third the diameter of the esophageal lumen)[13]

Data were entered and analyzed in the statistical software SPSS (version 23). Mean and standard deviation was calculated for continuous variable i.e. age, portal vein diameter, and splenic sizes. Frequencies and percentages were calculated for gender, EV grades, PVD groups, and ascites. The analysis of variance (ANOVA) was employed to test for significant differences of mean PVD among various EV groups. And independent sample t-test was applied between PVD and splenomegaly status, and PVD and ascites status, keeping 0.05 significant p- value with Levene statistics to assess for normality. Pearson correlation was used to see the association between PVD and spleen size

RESULTS

In this study 60 patients of CLD were included. There were 36(60%) male and 24(40%) female patients. The mean age of our patients was 50.7±

11.9years. The PVD ranged from 10 to 18mm, mean PVD being 14.1mm ±1.4. The splenic sizes ranged from 10 to 23 cm, with the mean splenic craniocaudal dimension being 14.9 cm ± 2.1.

The frequencies and percentages of EV groups, PVD, splenomegaly, and ascites status are shown in table 01.

Table 01. Frequencies and Percentages of PVD Groups, EV Groups, Splenomegaly, as cites .

Categorical Variable	Sub Group	Frequency/Percentage
Portal Vein Diameter Groups	< 13mm	10 (16.7 %)
	13mm to 13.9mm	14 (23.3 %)
	14mm to 14.9mm	14 (23.3 %)
	= 15mm	22 (36.7 %)
Esophageal Varices Groups	Small EV	14 (23.3 %)
	Medium EV	12 (20.0 %)
	Large EV	34 (56.7 %)
Splenomegaly	No	8 (13.3 %)
	Yes	52 (86.7 %)
Ascites	No	23 (38.3 %)
	Yes	37 (61.7 %)

The frequency of PVD groups as compared to grades of EV is shown in table 2. The highest association is between the large EV and PVD > 15 mm as shown in the above table i.e., 52% of total large EV.

Table 02. Frequency Portal Vein Diameter and EV Grading

Esophageal Varices Grade	Portal Vein Diameter group				Fisher Exact Test
	< 13mm	13 to 13.9mm	14 to 14.9mm	=15mm	
Small EV	6 (10%)	4 (6.7%)	3 (5 %)	1(1.7%)	p-value
Medium EV	1(1.7%)	6(10%)	2(3.3%)	3(5%)	0.003
Large EV	3 (5%)	4 (6.7%)	9 (15%)	18(30%)	

The results indicated statistically significant mean differences between PVD subgroup with respect to EV groups as determined by one-way ANOVA with F (2,57) =8.281, p= 0.001 as shown in table 3. Findings revealed that large esophageal varices had higher mean PVD as compared to small EV group with medium effect size. Post HOC comparisions indicated significant between group mean differences of PVD among large and small Esophageal Varices groups (significance level less than 0.05).

The correlation between PVD and EV Group variables was also statistically significant on Pearson's Correlation test (rs)[60] = 0.490, p < 0.001.

Table 03. Comparison of means of PVD and splenic size with different groups of EV utilizing ANOVA test.

	Oesophageal Variceal Grade			One-way ANOVA test (Analysis of Variance)
	Small EV	Medium EV	Large EV	P value
Portal Vein Diameter in mm (Mean ± SD)	13.0 ±1.25	14.0±1.39	14.7±1.27	0.001
Splenic size in cm	13.2±1.75	14.1±1.65	15.8±1.85	< 0.001

The mean PVD of patients with splenomegaly (M=14.4mm, SD =1.3) compared with the normal spleen (M=12.4mm, SD =1.15) demonstrated statistically significant increased diameter on independent T-test, t(58)= -3.978, p <0.001.

Table 04. Independent Sample T Test For Comparing Mean PVD In Splenomagaly, and ascites status with Levene statistics

		Levene's tests for equality of variances		t-test for Equality of Means		
		F	Sig	T	df	Sig (2-tailed)
PVD and Ascites	Equal variances assumed	0.809	.372	-3.978	58	.000
	Equal variances not assumed			-4.356	9.967	.001
PVD and splenomegaly	Equal variances assumed	0.694	0.408	-2.084	58	.042
	Equal variances not assumed			-2.147	51.246	.037

There has been increase in both portal vein diameter and size of spleen with progression of esophageal varices from small to large grade with a very significant p value <0.001.

Pearson correlation between PVD and spleen size also showed a significant positive association, (rs) [60]= 0.726; p<0.001).

An independent sample T-test showed a statistically significant difference in the mean PVD for patients with ascites (M=14.4mm, SD=1.47) as compared to patients with no ascites (M=13.7mm, SD=1.29) condition; t(58)= -2.084, p=0.042.

The variceal grade was assessed against splenic size, and the mean splenic size for different varices is given in Table 3 with one-way ANOVA, having statistically significant differences between splenic size with respect to three EV groups.

DISCUSSION

Cirrhosis is the final common pathway for most CLDs, affecting approximately 0.27% of the adult population.[14]The major complications include ascites and spontaneous bacterial peritonitis, hepatic encephalopathy, variceal bleeding, and hepatocellular carcinoma.[3] Out of these variceal bleeding is the most dreaded condition of all.[15] Up to 20% of variceal bleeds are refractory to standard therapy and associated with high mortality.[8]

In our study, we found a significant positive correlation betweenportal vein diameter (PVD) and EV as determined by one-way ANOVA (F (2,57) = 8.281, p = 0.001). The PVD for small varices was 13+/-1.25mm, 14+/-1.39mm for medium varies, and for large varices 14.7+/-1.27mm. The mean PVD for small varices was 12.6+/-0.7mm in a study by Bhattarai et al[16] in their study. Sudha Rani et al,[17]also documented a positive correlation between the grading of EV and PVDconcluding that PVD>13 mm can be considered as a non-invasive predictor of EV. Ravi Shanker et al,[18]studied two groups i.e., with and without varices. The mean PVD of patients with varices was 14.05±2.26 mm, p <0.01, with a positive correlation between PVD and grades of EV (r=0.7465), p<0.01. The correlation of our study was stronger with a correlation coefficient of 0.490, p<.001.

Ghosh et al,[19] analyzedthe PVD with respect to four EV grades and observed mean PVD of 10±1.15mm in grade I, 11.56±1.53mm in grade II, 12.75±1.6 mm in grade III and 14.46±0.52mm in grade IV. Among these, the mean PVD in grade IV is comparable to the mean PVD of 14.7+/-1.27mm for large varices in our study.

Our study also showed a difference in mean PVD for patients with and without splenomegaly, yielding a statistically significant P-value of 0.001. Faria et al,[15] used splenic craniocaudal measurements exceeding 12 cm for significant splenomegaly. The correlation between splenic size (>12cm) with the grading of EV was statistically significant (p<0.001), with a Correlation Coefficient of 0.737 for higher variceal grade and splenic enlargement of =15cm.

The results of Panjwani et al[9] also correlate with our study and shows statistically significant differences in mean spleen size 14.9cm +/- 2.99 (p<0.001) and PVD(p<0.001) of two groups of subjects, one with and the other without EV. Similarly, Sudha Rani et al[17] emphasized a significant correlation between the presence of EV with an increase in PVD (p-values <0.001) and with spleen size (p-value < 0.01). Ravi Shanker et al.[18] were of the same opinion thatthe average Spleen size in the variceal group (14.69±1.08cm) was higher than in the non-variceal group (12.45±0.65cm), p<0.01.

Our study showed a minor but statistically significant association between mean PVD and ascites and yielded a p-value of 0.042. The ascites was less common in our study i.e, 61 % compared to Uppalapati et al,[12] which showed ascites in 93.3% of patients, splenomegaly in 76.6% of patients, and PVD(>13mm) in 66.6% cases with Esophageal Varices.

Limitations

Our study sample didn't take a control group without varices (grade 0) and the duration of CLD was not taken into account. Patient habitus was not considered which may affect the splenic size.

CONCLUSION

As there is a significant positive correlation between PVD and grades of EV in CLD patients, the PVD on ultrasound should be utilized an endoscopic facility is not available, is overburdened or is refused by the patient. Moreover, it can also be used for monitoring small EVs after initial endoscopy in patients on medical treatment.

Conflict of Interest

Authors declare no conflict of interest

Grant Support and Financial Disclosure

NIL

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DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHOR'S CONTRIBUTION

The following authors full fill authorship criteria as per ICMJE guidelines;

Khan MI, Ahmad FS:	Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Afzal F, Sultan Z:	Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Nazar Z:	Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Khan JUA:	Analysis and interpretation of data, critical revision,final approval, agreed to be accountable for all the work.

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