Platelet count to splenic diameter ratio and other noninvasive markers as predictors of esophageal varices in patients with liver cirrhosis

Zubia Jamil[1], Maryam Malik[2], Asghar Aurangzeb Durrani[2]

[1]Department of Medicine, Foundation University Medical College, Foundation University, Islamabad, Pakistan
[2]Department of Medicine, Fauji Foundation Hospital, Rawalpindi, Pakistan

ABSTRACT

Background/Aims: Endoscopy as a screening modality for esophageal varices is becoming difficult because of its invasiveness, cost, and increased burden of liver cirrhosis. This study aims to determine the diagnostic accuracy of simple and noninvasive markers in detecting esophageal varices.

Materials and Methods: Four variables (platelet count, portal vein diameter, splenic diameter, and ratio of platelet count to splenic diameter PC/SD] ratio) were studied in 150 cirrhotic patients. Endoscopy was performed to detect esophageal varices in the patients. The diagnostic accuracy of these variables was determined by obtaining area under the receiver operating characteristic (ROC) curve (AUC). The cutoff value of each variable and its sensitivity, specificity, positive and negative predictive values, and positive and negative likelihood ratios were obtained using the Youden index. Pairwise comparison of these variables was performed using the Hanley and McNeil method to determine the most reliable screening tool among them.

Results: The PC/SD ratio was the most reliable indicator for the presence of varices: AUC=0.9 (p<0.0001; cutoff value, ≤1077.42; sensitivity, 88.75%; specificity, 81.43%). The AUC for platelets and splenic diameter was 0.85 (p<0.0001) and 0.77 (p<0.0001), respectively, showing they were also good indicators. The portal vein diameter was not a good predictor for esophageal varices (AUC=0.59). Pairwise comparison of these variables showed that the PC/SD ratio is statistically significant for predicting esophageal varices among these markers (p<0.05).

Conclusion: The PC/SD ratio is found to be the most reliable marker to prognosticate esophageal varices. It is easy to obtain and can be used with other markers to identify the high-risk patients for developing esophageal varices. It will definitely reduce the need for endoscopy as screening purposes and lower the medical expenditures.

Keywords: Platelet count, portal vein, esophageal varices, gastrointestinal endoscopy, portal hypertension, liver cirrhosis

INTRODUCTION

Liver cirrhosis is characterized by extensive fibrosis not only involving hepatic parenchyma but also the portal tract leading to the well-known complication of portal hypertension (1). Portal hypertension is interpreted by finding portal vein and hepatic vein pressure gradient exceeding 10-12 mmHg (2). Portal hypertension results in various clinical manifestations in patients with liver cirrhosis; however, the development of esophageal varix as sequelae of this portal hypertension results in a life-threatening situation in these patients (3).

Varices have placed a great health burden on patients with liver cirrhosis by affecting mortality and morbidity.

It is estimated that 50%-60% of liver cirrhotic patients have esophageal varices at the time of presentation to hospital. Moreover, 15%-20% of cirrhotic patients develop upper gastrointestinal bleeding due to esophageal varices per year, and 20%-30% of them die due to this bleeding within the first 4-6 weeks (4).

Therefore, it is recommended in the guidelines that upper gastrointestinal endoscopy should be performed in all cirrhotic patients to screen the presence of esophageal varices (5,6). This approach becomes difficult in developing countries where the burden of liver cirrhosis is high and use of endoscopy is limited by cost (5).

Jamil et al. Noninvasive markers predicting esophageal varices

Turk J Gastroenterol 2017; 28: 347-52

The predictive value of various noninvasive markers have been extensively studied in last two and more decades in detecting esophageal varices (2,3,7,8). These markers are emphasized to a large extend as they are simple, noninvasive, easy to obtain and interpret, and economical, with some markers having good accuracy in predicting esophageal varices. Importantly, patients show more inclination toward these noninvasive methods compared to upper gastrointestinal endoscopy (1).

Many noninvasive variables have replaced the need of liver biopsy for staging the degree of hepatic fibrosis (9,10). Among these, platelet counts and diameters of portal vein and spleen have found to be positively correlating with the histopathological changes of liver cirrhosis (9). Their role in predicting esophageal varices must be further evaluated.

Developing esophageal varices resulting from raised portal pressures in patients with liver cirrhosis has a great impact on defining the prognostic score as well as designing the management strategy in these patients. Upper gastrointestinal endoscopy for screening purposes in each patient with liver cirrhosis is not feasible in developing countries. The aim of this study was to assess the accuracy of noninvasive markers (platelet counts, portal vein diameter, splenic diameter, and ratio of platelet count to spleen diameter, PC/SD) in determining existing esophageal varices and thereby to propose them as a noninvasive, reproducible, safe, and accurate means for improving the management of cirrhotic patients.

MATERIALS AND METHODS

This was an analytical cross-sectional study conducted in the Department of Medicine Fauji Foundation Hospital Rawalpindi, Pakistan from April 2016 to December 2016.

In total, 150 patients with liver cirrhosis were selected. Patients were diagnosed based on history (exposure to risk factors, such as alcohol and chronic hepatitis B and C infections), past medical records, previous admissions due to ascites, hepatic encephalopathy, biochemical abnormalities in the presence of ultrasonography findings, or liver biopsy where available.

Factors affecting esophageal varices were used to exclude the patients from the study. These factors were use of beta-blockers for portal hypertension, endoscopic band ligation or sclerotherapy for esophageal varices, hepatocellular carcinoma, or evidence of portal vein thrombosis. Patients who were hemodynamically unstable due to upper gastrointestinal bleeding were excluded from the study.

The ethics committee of the hospital provided the approval before conducting the study. The patients were provided with detailed information regarding the study and written consent was obtained. Blood samples were drawn under complete aseptic measures by a trained phlebotomist to determine complete blood profile, liver function tests, prothrombin time with international normalized ratio (INR), serum albumin, and serum creatinine.

Patients were grouped into three classes according to Child-Pugh score A, B, and C using five parameters (hepatic encephalopathy, ascites, INR, albumin, and bilirubin) (11). The model for end-stage liver disease (MELD) score was also calculated using the standard MELD formula.

Four noninvasive markers (platelet counts, portal vein diameter, spleen diameter, and PC/SD ratio) were studied for their accuracy in predicting presence of esophageal varices.

For platelet count, 2 mL blood was drawn, collected in ethylene-diamie-tetra-aceticacid (EDTA)-containing tubes, and analyzed using an automated hematology analyzer. (Automated Hematology Analyzer XT-2000i, Sysmex Corporation, Japan). Normal values of platelet counts were $150\text{-}450 \times 10^9$/L.

Portal vein diameter and splenic diameter were assessed using transabdominal ultrasound. (Famio 5 ultrasound Machine, Abex Medical System, Toshiba, Japan). The normal portal vein diameter was less than 12 mm and splenic diameter was less than 110 mm.

Platelet count was divided by splenic diameter to get PC/SD ratio.

Upper gastrointestinal endoscopy was considered as a standard diagnostic modality for esophageal varices. All the patients underwent upper gastrointestinal endoscopy using GIF-XP160 video endoscope (Exera 160 series, Olympus Endoscopy System, Japan) to detect and grade esophageal varix.

Varices were graded into four grades I, II, III, and IV according to the Modified Paquet classification.

Statistical Analysis

Mean, standard deviation (SD), and ranges were used to scrutinize the quantitative data. Frequencies were obtained for quantitative variables. Contingency coefficient was used to show an association between esophageal varices and Child–Pugh classification of liver cirrhosis. The diagnostic accuracy of the four variables (platelet counts, portal vein diameter, splenic diameter, and PC/SD ratio) was determined by obtaining area under the receiver operating characteristic (ROC) curve. The cutoff point of each variable and sensitivity, specificity, positive likelihood ratio (+LR), negative likelihood ratio (-LR), positive predictive value (+PV), and negative predictive value (-PV) of this cutoff point was obtained using the Youden index with MedCalcC Software. To determine the most reliable screening tool among these four variables, pairwise comparison of these variables was performed by determining the differences between area under the curve (AUC) using the Hanley and McNeil method and compared using the MedCalcC software.

Turk J Gastroenterol 2017; 28: 347-52

Jamil et al. Noninvasive markers predicting esophageal varices

Statistical Package for Social Sciences version 20 (IBM Corp.; Armonk, NY, USA) was also used for analyzing the data.

RESULTS

The mean age of 150 patients of this study group was 52.59±12.62 years (mean±SD) with ranges 16-77 years. Among 150 patients, 48 (32%) were males and 102 (68%) were females. Infection with chronic hepatitis C was found to be the foremost cause affecting 132 (88%) patients. Other causes of liver cirrhosis were chronic hepatitis B virus infection with 4 (2.7%) patients and Wilson's disease with 4 (2.7%) patients, while 10 (6.7%) patients were having sero-negative liver cirrhosis.

Overall, 85 (56.7%) patients belonged to Child-Pugh Class A, while 59 (39.3%) to Child-Pugh Class B; 6 (4%) patients belonged to Child-Pugh Class C. The MELD score of patients was 10.006±5.232 (mean and SD) with ranges 6.00-38.00.

In total, 24 (16%) patients were having esophageal varices grade I, 15 (10%) were having grade II, 33 (22%) were having grade III, and 5 (3.3%) were having grade VI; 73 (48.7%) patients were not having esophageal varices on upper gastrointestinal endoscopic examination. In addition, 62 (41.3%) patients were having associated portal hypertensive gastropathy; in addition, 8 (5.3%) patients were having fundal varices.

The presence of esophageal varices regardless of their sizes was found to be notably related to the Child-Pugh class of liver cirrhosis. (contingency coefficient=0.3; p<0.05; Table 1)

The laboratory parameters of 150 patients with liver cirrhosis are shown in Table 2.

Platelet count was 131.38±66.68x10⁹/L (mean±SD) with range 26-422×10⁹/L. Area under the ROC curve for platelet count was 0.859 (95% confidence interval [CI], 0.793-0.910; standard error [SE], 0.0338; p<0.0001). The cutoff point for platelets for detecting esophageal varices was found to be ≤142×10⁹/L. This cutoff point had sensitivity, 93.75%; specificity, 72.86%; +LR, 3.45; -LR, 0.086; +PV, 27.7; and -PV, 99.1.

The portal vein diameter was 12.07±2.52 mm (mean±SD) with range 7-22 mm. Area under the ROC curve for prediction of varices by portal vein diameter was 0.591 (95% CI, 0.508-0.670; SE, 0.0467; p 0.05). The cut off point for portal vein diameter was >12 mm (sensitivity, 51.25%; specificity, 65.71%; +LR, 1.49;-LR, 0.74; +PV, 14.2;-PV, 0.406).

Splenic diameter was 130.08±25.16 mm (mean±SD) with range 12-185 mm. The AUC for splenic diameter was 0.779 (95% CI, 0.704-0.842; SE, 0.0381; p<0.0001). The cutoff point of splenic diameter for detecting esophageal varices was >110 mm (sensitivity, 83.75%; specificity, 64.29%; +LR, 2.35; -LR, 0.25; +PV, 20.7;-PV, 97.3).

Table 1. Presence of esophageal varices in Child-Pugh Class A, B, and C of patients with liver cirrhosis

| | | Endoscopic outcomes | | |
		Positive	Negative	Total
Child-Pugh class	A	29	56	85
	B	46	13	59
	C	3	3	6
Total		78	72	150

Table 2. Laboratory parameters (complete blood count, liver function tests, serum electrolytes, and coagulation profile) of 150 patients with liver cirrhosis

	N	Minimum	Maximum	Mean	SD
Hemoglobin g/dL	150	3.47	16.00	9.8343	2.32919
WCC×109 cells/L	150	0.87	15.98	5.8281	2.83457
Na mEq/L	150	132.00	144.00	138.2467	2.56705
K mEq/L	150	3.70	5.60	4.2453	.37961
Cl mEq/L	150	90.00	106.00	99.5333	2.84892
Bilirubin μmol/L	150	7.00	189.00	24.5667	27.61928
ALT IU/L	150	18.00	279.00	54.0133	42.53305
ALP IU/L	150	105.00	675.00	231.7733	110.84690
Albumin g/dL	150	2.20	4.40	3.5140	0.53633
PT (sec)	150	1.00	10.00	2.4800	2.19432
INR	150	1.00	4.50	1.1637	.42670

WCC: white cell count; Na: sodium; K: potassium; Cl: chloride; ALT: alanine aminotransferase; ALP: alkaline phosphatase; PT: prothrombin time; INR: international normalized ratio; SD: standard deviation

The PC/SD ratio was 1119.678±960.78 (mean±SD) with range 236.36-10083.33. The AUC for PC/SD ratio was 0.883 (95% CI, 0.821 to 0.930; SE, 0.0303; p<0.0001). The cutoff point for PC/SD was ≤1077.42 (sensitivity, 88.75%; specificity, 81.43%; +LR, 4.78;-LR, 0.14; +PV, 34.7; -PV, 98.5). (Table 3, Figure 1).

The pairwise comparison of the areas under the ROC curves of the four noninvasive parameters (platelets, portal vein diameters, splenic diameter, and PC/SD ratio) showed that the PC/SD ratio is statistically significant for determining the presence of esophageal varices compared to portal vein diameter and splenic diameter alone (p<0.0001 and p<0.011, respectively); however, this was not more significant than was platelet count for determining esophageal varices (p0.13). Platelet count was statistically significant than the portal vein diameter for esophageal varices prediction with p<0.0001, but it was not more significant than splenic diameter (p0.09). The pairwise comparison of ROC curves is shown in the Table 4.

Jamil et al. Noninvasive markers predicting esophageal varices

Turk J Gastroenterol 2017; 28: 347-52

Table 3. Diagnostic accuracy of noninvasive parameters in determining esophageal varices with regard to AUC, cutoff value, sensitivity, specificity, positive and negative likelihood ratios, and positive and negative predictive values

Parameter	AUC	Cutoff point	Sensitivity	95% CI	Specificity	95% CI	+LR	95% CI	-LR	95% CI	+PV	-PV
PC	0.859	≤142	93.75	86.0 - 97.9	72.86	60.9 - 82.8	3.45	2.3 - 5.1	0.086	0.04 - 0.2	27.7	99.1
PV	0.591	>12	51.25	39.8 - 62.6	65.71	53.4 - 76.7	1.49	1.0 - 2.2	0.74	0.6 - 1.0	14.2	92.4
SD	0.779	>110	83.75	73.8 - 91.1	64.29	51.9 - 75.4	2.35	1.7 - 3.3	0.25	0.1 - 0.4	20.7	97.3
PC/SD	0.883	≤1077	88.75	79.7 - 94.7	81.43	70.3 - 89.7	4.78	2.9 - 7.9	0.14	0.07 - 0.3	34.7	98.5

PC: platelet count; PV: portal vein; SD: splenic diameter; PC/SD: platelet count to splenic diameter ratio; AUC: area under curve; +PV: positive predictive value; -PV: negative predictive value; +LR: positive likelihood ratio; -LR: negative likelihood ratio; CI: confidence interval

Table 4. Pairwise comparison of differences between area under ROC curve and p value of noninvasive parameters in determining esophageal varices

	Differences between AUC	SE	95% CI	Z statistics	Significance level
Platelets~Portal Vein	0.268	0.0554	0.160 to 0.377	4.842	p<.0001
Platelets~Splenic Diameter	0.0801	0.0475	-0.0129 to 0.173	1.687	p=0.0916
Platelets~PC/SD	0.0245	0.0165	-0.00785 to 0.0568	1.484	p=0.1379
Portal Vei~Splenic Diameter	0.188	0.0506	0.0888 to 0.287	3.715	p=0.0002
Portal Vein~PC/SD	0.293	0.0543	0.186 to 0.399	5.387	p<0.0001
Splenic Diameter~PC/SD	0.105	0.0411	0.0240 to 0.185	2.543	p=0.0110

PC: platlett count; PV: portal vein; SD: splenic diameter; PC/SD: platelet count to splenic diameter ratio; AUC: area undercurve; SE: standard error; CI: confidence interval
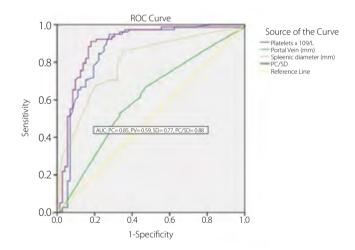
Figure 1. Receiver operating curve (ROC) showing the area under the curve (AUC) for platelets, portal vein, splenic diameter, and PC/SD ratio in determining esophageal varices. ROC showing the AUC for platelets, portal vein, splenic diameter, and PC/SD ratio in determining esophageal varices; AUC is maximum for the PC/SD ratio of 0.88 and minimum for portal vein diameter. This shows that the PC/SD ratio is the most reliable marker for predicting esophageal varices

DISCUSSION

All international societies for the study of liver diseases have recommended the screening of every patient diagnosed with liver disease for esophageal varices (6). This proposal is difficult to achieve in many countries where the burden of liver cirrhosis is becoming high and upper gastrointestinal endoscopy is difficult as it is an invasive and high-priced screening modality. Thus, in last few decades, a large multitude of studies have been conducted to determine the accuracy of different noninvasive markers in detecting esophageal varices (3,12).

This study focused on four noninvasive parameters - platelets, portal vein diameter, spleen diameter, PC/SD ratio.

Platelet Count

Many studies have shown that a positive relationship of thrombocytopenia with presence as well as grades of esophageal varices (13,14). We also found that thrombocytopenia is a good indicator of existing esophageal varices (AUC=0.85). We found that a cutoff point for less than 142×10^9/L has higher sensitivity of 94% and specificity of 73% in detecting esophageal varices regardless of their grades compared to the study conducted by Abd-Elsalam et al. (5). They found that platelet counts less than 149×10^9/L has sensitivity of 40%, but specificity of 82%. The cutoff point of 142 for platelet has shown more sensitivity in our study.

Portal Vein Diameter

Portal vein diameter, estimated by transabdominal ultrasound, is found to be an unsatisfactory noninvasive marker for predicting the esophageal varices (AUC=0.591; p=0.05) in our study. Many studies have shown similar results that ultrasound-dependent variables, such as vessel diameters and changes in waveforms, are poorly correlated with the presence of esophageal varices (15). In contrast, some studies have suggested them as a useful marker for determining esophageal varices (16,17). In these studies, portal vein and hepatic vein diameters are combined, their waveform changes, and the transient time is estimated using contrast-enhanced ultrasonography. In our study, we have simply considered the diameter of portal vein and not used any combination with hepatic veins, waveform changes, or transient time.

Turk J Gastroenterol 2017; 28: 347-52

Jamil et al. Noninvasive markers predicting esophageal varices

Splenic Diameter

The area under the ROC curve for splenic diameter in our study was found to be 0.779. Sensitivity of 84% and specificity of 64% was found for the splenic diameter of >110 mm. Many studies have proposed that splenomegaly is a good indicator of raised portal pressures and hence presence of varices (14). One study conducted by Gonzalez-Ojeda et al. (18) has found that splenomegaly has high specificity compared to thrombocytopenia in determining esophageal varices; however, in this study, we found that it is less sensitive and specific marker compared to thrombocytopenia for detecting esophageal varices.

Pc/Sd Ratio

In our study, we found that area under the ROC curve for PC/SD ratio was approximately 0.9 (0.88) indicating that this variable can be used as a simple noninvasive tool for determining the presence of esophageal varix. Many studies have proposed that the PC/SD ratio >909 has high reliability in predicting esophageal varices (3,14,19). Giannini et al. (20) also proposed in their study that the PC/SD ratio of 909 has high sensitivity and specificity value for predicting esophageal varix. We found that the cutoff point for this ratio was 1077 (sensitivity, 89% and specificity, 81%). This cutoff value was higher than 909. Similar difference of cutoff value was found in a study conducted by Gonzalez-Ojeda et al. (18) and they found a cutoff point of 884. It is proposed that cutoff value of PC/SD ratio varies from population to population, and each population should define their own cutoff value (18). In addition, one study conducted by Kaji et al. (21) found the cutoff point 1000 with high sensitivity and specificity, which is very close to that of our study. Chawla et al. (22) carried out a large meta-analysis that also showed similar results.

The differences of area under the ROC curves of these four noninvasive variables showed that the PC/SD ratio is the most reliable marker in predicting esophageal varices among them. This study showed that the PC/SD ratio is statistically significant in determining varices compared to portal vein diameter and splenic diameter alone (p<0.05). Although the difference of area under the curve for platelets and PC/SD ratio is not significant, in this study, thrombocytopenia was found to have a low specificity of 72% compared to PC/SD ratio, which has both good sensitivity and specificity of 89% and 81%, respectively, rendering it a more reliable marker among them.

Noninvasive parameters can be used as a screening tool for identifying esophageal varix. Platelets to splenic diameter ratio is the most reliable marker for scrutinizing the patients who are at increased risk of developing esophageal varix. Such patients can undergo upper gastrointestinal endoscopy for further management. The use of PC/SD ratio and other noninvasive markers will definitely reduce the burden on upper gastrointestinal endoscopy as screening purposes and lower the medical expenditures.

REFERENCES

1. Sebastiani G, Gkouvatsos K, Pantopoulos K. Chronic hepatitis C and liver fibrosis. World J Gastroenterol 2014; 20: 11033-53. [CrossRef]
2. Ripoll C, Groszmann R, Garcia-Tsao G,et al. Hepatic venous pressure gradient predicts clinical decompensation in patients with compensated cirrhosis. Gastroenterology 2007; 133: 481-8. [CrossRef]
3. Cho EJ, Kim MY, Lee J-H, et al. Diagnostic and Prognostic Values of Noninvasive Predictors of Portal Hypertension in Patients with Alcoholic Cirrhosis. PLoS One 2015;h10: e0133935.
4. Lim YS. Practical approach to endoscopic management for bleeding gastric varices. Korean J Radiol. 2012; 13: 40-4. [CrossRef]
5. Abd-Elsalam S, Habba E, Elkhalawany W, et al. Correlation of platelets count with endoscopic findings in a cohort of Egyptian patients with liver cirrhosis. Medicine (Baltimore) 2016; 95: e3853. [CrossRef]
6. Garcia-Tsao G, Sanyal AJ, Grace ND, Carey W. Prevention and management of gastroesophageal varices and variceal hemorrhage in cirrhosis. Hepatology 2007; 46: 922-38. [CrossRef]
7. Rye K, Mortimore G, Austin A, Freeman J. Non-invasive Diagnosis of Oesophageal Varices Using Systemic Haemodynamic Measurements by Finometry: Comparison with Other Non-invasive Predictive Scores. J Clin Exp Hepatol 2016; 6: 19-202. [CrossRef]
8. Abraldes JG, Bureau C, Stefanescu H, et al. Noninvasive tools and risk of clinically significant portal hypertension and varices in compensated cirrhosis: The "Anticipate" study. Hepatology. 2016; 64: 2173-84. [CrossRef]
9. Zhang E-L, Zhang Z-Y, Wang S-P, et al. Predicting the severity of liver cirrhosis through clinical parameters. J Surg Res 2016; 204: 274-81. [CrossRef]
10. Kang W, Kim SU, Ahn SH. Non-invasive prediction of forthcoming cirrhosis-related complications. World J Gastroenterol 2014; 20: 2613-23. [CrossRef]
11. Peng Y, Qi X, Guo X. Child-Pugh Versus MELD Score for the Assessment of Prognosis in Liver Cirrhosis: A Systematic Review and Meta-Analysis of Observational Studies. Medicine (Baltimore) 2016; 95: e2877. [CrossRef]

Jamil et al. Noninvasive markers predicting esophageal varices

Turk J Gastroenterol 2017; 28: 347-52

12. Nashaat EH, Abd-Elaziz H, Sabry M, Ibrahim AA. Non-endoscopic predictors of esophageal varices and portal hypertensive gastropathy. Nat Sci 2010; 8: 43-50.

13. Abbasi A, Butt N, Bhutto AR, Munir SM. Correlation of thrombocytopenia with grading of esophageal varices in chronic liver disease patients. J Coll Physicians Surg Pakistan 2010; 20: 369-72.

14. Giannini E, Botta F, Borro P, et al. Platelet count/spleen diameter ratio: proposal and validation of a non-invasive parameter to predict the presence of oesophageal varices in patients with liver cirrhosis. Gut 2003; 52: 1200-5. [CrossRef]

15. Bhutto AR, Abbasi A, Butt N, Khan A, Munir SM. Hepatic vein waveform in liver cirrhosis: correlation with child's class and size of varices. J Pak Med Assoc 2012; 62: 794-7

16. Zhuang Y, Ding H, Han H, et al.Clinical value of contrast-enhanced ultrasound in evaluating portal hypertension in patients with decompensated liver cirrhosis. Zhonghua Gan Zang Bing Za Zhi 2016; 24: 270-4.

17. Sudha Rani KVL, Sudarsi B, Siddeswari R, Manohar S. Correlation of portal vein size with esophageal varices severity in patients with cirrhosis of liver with portal hypertension. IJSRP 2015; 5: 1-5.

18. Gonzalez-Ojeda A, Cervantes-Guevara G, Chavez-Sanchez M,et al. Platelet count/spleen diameter ratio to predict esophageal varices in Mexican patients with hepatic cirrhosis. World J Gastroenterol 2014; 20: 2079-84. [CrossRef]

19. Ozdil K, Ozturk O, Calik ES, et al. Relationship between size of varices and platelet count/spleen size ratio in cirrhotic patients. North Clin Istanb 2016; 3: 46-52.

20. Giannini EG, Zaman A, Kreil A, et al. Platelet count/spleen diameter ratio for the noninvasive diagnosis of esophageal varices: results of a multicenter, prospective, validation study. Am J Gastroenterol 2006; 101: 2511-9. [CrossRef]

21. Kaji BC, Bhavsar YR, Nitin P, Garg A, Kevadiya H, Mansuri Z. A study of clinical profile of 50 patients with noninvasive predictor of esophageal varices. Ind J Clin Pract 2012; 22: 454-7.

22. Chawla S, Katz A, Attar BM, Gupta A, Sandhu DS, Agarwal R. Platelet count/spleen diameter ratio to predict the presence of esophageal varices in patients with cirrhosis: a systematic review. Eur J Gastroenterol Hepatol 2012; 24: 431-6.[CrossRef]

Original Article