H. Rokni Yazdi MD[1].
M. R. Khalilian MD[2].

Sonographic Assessment of Respiratory Variations in Diameter of Portal and Splenic Veins in Cirrhotic Patients and Healthy Controls

Background/Objectives: This study was designed to assess the sensitivity and specificity of respiratory changes in the diameter of splanchnic veins in non invasive diagnosis of cirrhosis regardless of the portal pressure (about 60% of cirrhotic patients have signs of portal hypertension).

Patients and Methods: In this study, 36 biopsy-proven cirrhotic patients were selected as the case group and 36 healthy people as the controls. All patients had overnight fasting, and ultrasonography was performed both in normal and deep inspiration. The portal vein diameter was measured where it crosses the IVC; and the splenic vein at the splenic hilum.

Results: An increased diameter of the portal (>13 mm) and splenic veins (>10mm) had a high specificity (94% and 97%, respectively) but a low sensitivity (31% and 42%) in the diagnosis of cirrhosis.

Reduced respiratory changes of diameter (equal or less than 20% for the portal vein and 50% for the splenic vein) had higher sensitivity and specificity (89% and 89% for the portal vein; and 100% and 83% for the splenic vein). Portal vein thrombosis was noted in 17.3%.

Conclusion: Reduced respiratory changes in diameters of the portal and splenic veins not only has high sensitivity and specificity for diagnosing portal hypertension (as previous studies proved it) but also has similar high sensitivity and specificity for diagnosing cirrhosis regardless of portal pressure.

Keywords: cirrhosis, portal hypertension, portal vein, splenic vein, ultrasonography

1. Assistant Professor, Department of Radiology, Imam Khomeini hospital, Tehran University of Medical Science, Tehran, Iran.
2. Department of Radiology, Imam Khomeini hospital, Tehran University of Medical Science, Tehran, Iran.

Corresponding Author:
Hadi Rokni Yazdi
Address: Medical Imaging Center, Imam Khomeini Hospital, Tehran, Iran.
PO Box: 1419733141
Tel: 009821-66438631-3
Fax: 009821-66945117
Mobile: 0098912-1975457
E mail: Hadirokni@yahoo.com

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Introduction

Cirrhosis is the irreversible end result of fibrous scarring and hepatocellular regeneration that constitutes the major response of the liver to a variety of longstanding inflammatory, toxic, metabolic and congestive insults.[1] Different studies show that ultrasonography of the liver surface with high frequency probes for detection of diffuse nodularity has a sensitivity of 88% and a specificity ranging from 81 to 95% .[2]

Another important factor in the diagnosis of cirrhosis is assessment of sonographic signs of portal hypertension. The most important signs are as follows:

1. Increased diameter of splanchnic veins: an increased portal vein diameter more than 13 mm in quiet inspiration and supine position has a specificity of (95-100%) but a low sensitivity (42%); an increased diameter of the splenic vein near the superior mesenteric vein (SMV) insertion; and the SMV diameter more than 10 mm.[2, 3]

2. Portosystemic collateral formation: the mostimportant collaterals are coronary,

short gastric, umbilical and splenorenal.

3. Respiratory variations of splanchnic veins' diameter: in patients with portal hypertension, lack of normal diameter variation (<50% increase during deep inspiration) has a sensitivity of 80% and specificity of 95-100% for diagnosing portal hypertension.[2] The pathophysiology of respiratory changes of splanchnic veins in normal individuals is: In deep inspiration, the diaphragmatic descent causes compression of the hepatic venous outflow that may cause more than 50 to 100% increase in diameters of the splenic vein and/or the SMV, but in portal hypertension the portal venous system is already maximally distended and cannot be distended further. Moreover, the respiration-induced changes of pressure are poorly transmitted through the scarred liver.[4] Because only 60% of cirrhotic patients have clinically significant portal hypertension[5] and the previous studies assessed these findings in cirrhotic patients with proven portal hypertension, this question remains that if these changes are due to portal hypertension, cirrhosis or both. We tried to assess whether the reduced respiratory changes due to cirrhosis itself can be a good non-invasive screening test for cirrhosis, regardless of the existing portal hypertension, and comparing the findings in cirrhotic patients and the control group.

Liver biopsy is the gold standard for diagnosing cirrhosis but it is an invasive method. Ultrasonography is a non-invasive, inexpensive and available method in the diagnosis of cirrhosis.

Patients and Methods

In this study, 46 biopsy-proven cirrhotic patients who were referred to the radiology department of Imam Hospital in 2003-2004 were selected as the patient group. Eight patients had portal vein thrombosis and in 2 patients the portal or splenic veins could not be assessed properly due to incomplete bowel preparation; these ten patients were excluded from our study. Thirty-six healthy individuals with no previously known cirrhosis or portal hypertension and with normal liver function tests (AST, ALT, and bilirubin) were selected as the control group. The participant were selected by convenient sampling.

Both groups had overnight fasting and ultrasonograph was performed in the supine position both in normal and deep inspiration with an EUB 450 ultrasound machine (Hitachi Co, Japan); and a radiologist with 5 years' work experience in a referral gastroenterology center performed the sonographies. The location for the portal vein measurement was the point the portal vein and the IVC crossed and the splenic hilum for the splenic vein. The central portions of cursors were fixed in the echogenic wall of veins for measurements (Figure1). The information was recorded in questionnaires and analyzed with SPSS software, using the chi-square and Mann-Whitney tests. All patients and the control group were informed about the procedure and this study was approved by the ethics committee of Tehran University of Medical Sciences.

Results

Ten patients were excluded from our study; 8 due to portal vein thrombosis (17.3%) and 2 for incomplete bowel preparation. Thirty-six cirrhotic patients were included in our study (22 male and 14 female, with the mean age of 45 years).

An increased portal vein diameter of more than 13 mm was noted in 32.35%; and a splenic vein diameter of more than 10mm was noted in 41.67% of the patients. The portal vein diameter > 13mm and splenic vein >10 mm had respective specificities of 94% and 97% but a low sensitivity (31% and 42%) in the diagnosis of cirrhosis.

Reduced respiratory variations (≤20% for the portal vein and ≤50% for the splenic vein) had a higher sensitivity and specificity for diagnosing cirrhosis. Respective sensitivity and specificity for the portal vein was 89% and 89%; and for the splenic vein, 100% and 83% (Tables 1 and 2).

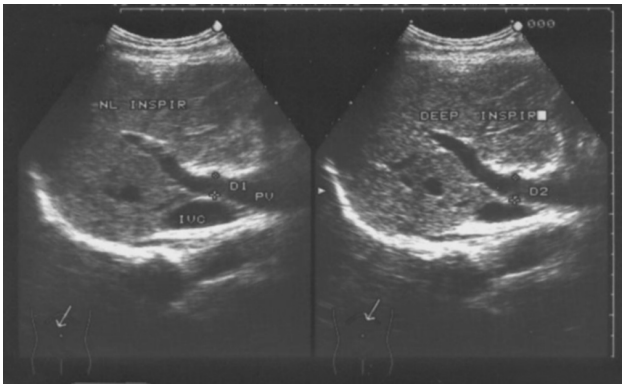

Fig 1. Measurement of portal vein diameter in normal and deep inspiration. Note that site of measurement is in crossing point of portal vein and IVC and midpoint of cursors is fixed in echogenic walls of portal vein.

No statistically significant difference was noted in association with age or gender between the case and control groups (P=0.91, P=0.629)

The patients' mean duration of known cirrhosis was 5 years.

The most common etiology of cirrhosis was viral hepatitis (70%) in our study that is different from the literature that states alcoholic cirrhosis is the most common cause of cirrhosis (60%).[6] This may be due to less alcohol consumption in our country and the higher incidence of viral hepatitis.

Collateral vasculature was noted in 58.3%; the most common being splenorenal (27.8%) and coronary (8%) (Table 3).

Discussion:

An increased diameter of the portal or splenic veins was noted in 55.5% of our patients. Similar studies noted an increased diameter of splanchnic vein in 76% of patients.[7] This difference may be attributed to not measuring the SMV diameter in our study.

In our cirrhotic patients, the mean diameter of portal vein in normal respiration was significantly more than the control group's (11.6 mm versus 8.9 mm) but in deep inspiration this difference was not statistically significant (12.6 mm versus 12.2 mm) (Table 1).

Portal vein diameters >13mm had 30.6% sensitivity and 94.4% specificity for diagnosing cirrhosis in our study (Table 2).

The mean diameter of splenic vein in normal respiration was significantly more than the control group's (8.6mm versus 5.7mm) but in deep inspiration their difference was not statistically significant (9.4 mm versus 9.1mm) (Table1).

Splenic vein diameters >10 mm during normal respiration were noted in 41.7% of our patients (Table 1) having a sensitivity of 41.7% and specificity of 97.2%

Table 1. Comparison of the findings in the case and control groups

Variable	P value	Control	Case
Gender(male)	0.624	22(61.1%)	24(66.7%)
Age	0.91	45±13.1	45.4±16.3
Increased gall bladder wall thickness >3mm	-	-	24(66.7%)
Splenomegaly	-	-	26(72.2%)
Ascites	-	-	19(52.8%)
Portal vein diameter in normal inspiration	0.0001	8.9±108	11.6±2.5
Portal vein diameter in deep inspiration	0.551	12.2±2.3	12.6±2.6
Portal vein diameter >13mm in normal inspiration	-	2(5.6%)	11(30.6%)
Splenic vein diameter in normal inspiration	0.0001	5.7±1.5	8.6±2.8
Splenic vein diameter in deep inspiration	0.628	9.4±2.2	9.1±2.9
Splenic vein diameter >10mm in normal inspiration	-	1(2.8%)	15(41.7%)
Change in portal vein diameter with deep inspiration	0.0001	3.2±1.2	0.96±1.0
> 20% increase in portal vein diameter in deep inspiration	-	32(88.9%)	4(11%)
Increased splenic vein diameter in deep inspiration	0.0001	3.7±1.0	0.5±0.75
> 50% increase in splenic vein diameter with deep inspiration	-	30(83%)	0(0%)
Mean increase in portal vein diameter with deep inspiration	0.48	7.3%±10.1	8.7%±10.2
Mean increase in splenic vein diameter with deep inspiration	0.0001	68.1%+/-20	7.3+/-10.1

Table 2. Sensitivity, specificity, positive predi ctive value (PPV), negative predictive value (NPV) and accuracy of the portal vein (P.V .) and the splenic vein (S.V.) diameter measurement in normal and deep inspiration for diagnosing cirrhosis.

	Sensitivity	Specificity	PPV	NPV	Accuracy
P.V. diameter > 13mm in normal inspiration	30.6%	94.4%	84.6%	42.3%	62.5%
S.V diameter > 10mm in normal inspiration	41.7%	97.2%	93.7%	62.5%	69.4%
≤20% increase in P.V diameter with deep inspiration	88.9%	88.9%	88.9%	88.9%	88.9%
≤20% increase in S.V. diameter with deep inspiration	88.9%	100%	100%	90%	94.4%
≤50% increase in S.V. diameter with deep inspiration	100%	83.3%	85.7%	100%	91.7%

Table 3. Different types of collaterals noted on ultrasonography of cirrhotic patients

Collateral	Percentile	No.
Splenorenal	27.8%	10
Coronary	8.3%	3
Umbilical	5.6%	2
Splenorenal and coronary	5.6%	2
Splenorenal and umbilical	2.8%	1
Splenorenal and short gastric	2.8%	1
Umbilical and coronary	2.8%	1
4 collaterals simultaneously	2.8%	1
No detectable collaterals	41.71	15

for diagnosing cirrhosis (Table 2).

In the case group, the average increase in the portal vein diameter with deep inspiration was significantly lower than the control group (1 mm versus 3.2mm)

In 88.9% of cirrhotic patients, increase in the portal vein diameter with deep inspiration was less than 20% but in the control group, 88.9% had a 20% or more increase in the portal vein diameter with deep inspiration. Therefore, in our study, the specificity and sensitivity of a ≤20% increase in the portal vein diameter with deep inspiration was 88.9% for diagnosing cirrhosis (Table 2). The average increase in the splenic vein diameter with deep inspiration was significantly higher in the case group in comparison to the controls (3.7 mm and 0.5 mm, respectively). In our study, we noted a ≤20% increase in the splenic vein diameter in 88.9% of cirrhotic patients; but in the control group, everyone had a ≤20% increase in the splenic vein diameter with deep inspiration. All of the cirrhotic patients had ≤50% increase in the splenic vein diameter, but in the control group only 16.6% had such finding. Therefore, the specificity and sensitivity of a ≤20% increase in the splenic vein diameter with deep inspiration were 88.9% and 100%; and a ≤50% increase had 100% sensitivity and 83.3% specificity for diagnosing cirrhosis (Table 3).

These results showed that a ≤50% increase in the splenic vein diameter was a better screening measure. In a similar study, these findings had 80% sensitivity and 95-100% specificity for diagnosing portal hypertension.[2] A ≤ 20% increase in the splenic vein diameter with deep inspiration had 81% sensitivity and 100% specificity in another study.[3]

High sensitivity and specificity of the reduced respiratory changes in diameters of splanchnic veins in our study, that is similar to the results of the studies on cirrhotic patients with evidenced portal hypertension, may imply that either most of these changes are due to cirrhosis itself regardless of portal hypertension, or most of our patients (that were randomly selected) incidentally had portal hypertension.

These theories can be evaluated in the future studies comparing two groups of cirrhotic patients with and without evidenced portal hypertension.

Portal vein thrombosis noted in 17.3% of our patients is significantly higher than the similar studies (3.4%).[8] About 58.3% of our patients had collateral veins, as in other studies (44% and 85%).[7,8] The most common collateral in our patients was splenorenal (47.6% of all collaterals) (Table 3). In other studies, the umbilical collaterals were more common (58%).

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