

Diagnosis of portal hypertension by transabdominal ultrasound

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Abstract

Portal hypertension is pathologic increase in portal venous pressure, with diversion of portal blood to the systemic circulation. The study was directed to measure as well as to compare the diameters of splenic, superior mesenteric and portal veins with their variation with respiration in normal subjects and in patients with portal hypertension. An analytic type of cross-sectional study was conducted at Radiology and Imaging Department of BIRDEM, Shahbag, Dhaka for one year (2011-12) among purposively selected 59 study subjects with chronic liver disease and portal hypertension, and 45 individuals without liver disease. Transabdominal ultrasonography of hepatobiliary system was carried out using computed sonography system with multiple probes having multiple frequency depending on physical built of the subjects. The diameters of selected veins were measured in the course of expiration and deep inspiration. In all control subjects, diameter variations of splenic vein and superior mesenteric vein were noted in the phases of respiration, the diameters increased during deep inspiration and decreased during deep expiration mean diameter and standard deviation of splenic vein and superior mesenteric vein were 6.95 ± 1.75 mm and 8.77 ± 2.06 mm respectively and during expiration they were 4.45 ± 1.24 mm and 5.66 ± 1.41 mm respectively. The difference in deep inspiratory and expiratory diameters had high statistical significance ($p < 0.0001$). Patients with portal hypertension diameter variation with breathing at the level of splenic and superior mesenteric veins was observed only in 5 (9.47%) cases. Diminished response of splenic and superior mesenteric veins with respiration in transabdominal ultrasonography is an indicator of portal hypertension.

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Introduction

Portal hypertension is a clinical syndrome characterized by a pathologic increase in portal venous pressure with the formation of porto-systemic collaterals that divert portal blood to the systemic circulation, bypassing the liver.¹ The dominant intrahepatic cause of portal hypertension is cirrhosis.² Portal hypertension in cirrhosis is mainly due to increased resistance to portal flow at the level of hepatic sinusoid due to narrowing of the sinusoidal channels by perisinusoidal deposition of collagen, and compression of central veins by perivenular fibrosis and expansile parenchymal nodules. Worldwide, the most common causes of cirrhosis are chronic viral hepatitis and prolonged excessive alcohol consumption.³ Viral hepatitis is the commonest cause of chronic hepatitis in Bangladesh. Based on the principal sites of obstruction to blood flow in the portal venous system, portal hypertension can be classified into presinusoidal (extrahepatic and intrahepatic), sinusoidal (intrahepatic), and postsinusoidal

(intrahepatic and extrahepatic). Despite all possible causes, portal hypertension indicates cirrhosis until proved otherwise.² Formation of portosystemic venous shunts, ascites, congestive splenomegaly and occasionally hepatic encephalopathy are the major clinical consequences of portal hypertension.² As many as 30 to 70 per cent of the patients of liver cirrhosis with portal hypertension develop oesophageal varices. Bleeding from ruptured oesophageal varices is one of the serious complications with case fatality rate of 20 to 50 per cent.⁴⁻⁶ The most important symptoms of liver cirrhosis, haemorrhage from oesophageal varices and ascites are due to circulatory alterations at the portal venous system. It is important to get information about portal venous system with the aim of discovering portal hypertension in patients with asymptomatic chronic disease.⁷ As a rule, oesophagoscopy and barium examination of the oesophagus are commonly carried out to detect oesophageal varices. However, this is sufficient to establish the presence of portal hypertension but

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not its cause(s). As these examinations obviously fail to provide information regarding morphology of main portal vessels. Portal venography demonstrates the site and often the cause of portal venous obstruction which is performed prior to surgical intervention. Arterio-portography and contrast enhanced spiral CT may be used for evaluating extrahepatic portal problem. Hepatic venography can be diagnostic for post-hepatic portal hypertension. Portal venous pressure measurements rarely needed but can be carried out for confirmation of portal hypertension. All these methods bear some degree of risk and generally encounter a certain unwillingness on the part of the patients. Sonography, in addition of being non-ionizing, its accessibility, noninvasiveness, portable nature, reliability, low cost and also its ability of rapidly accomplishment, makes it a good diagnostic tool. The study was aimed to measure as well as to compare the diameters of splenic, superior mesenteric and portal veins with their variation with phases of respiration in normal subjects and in patients with portal hypertension by trans-abdominal ultrasonography that would help in detecting the cause with portal hypertension.

Materials and Methods

An analytic type of cross-sectional study was carried out among purposely selected 59 study subjects with chronic liver disease and portal hypertension, and 45 individuals without liver disease. Study subjects were selected from in-patient department, whereas controls were selected from out-patient as well as in-patients departments. Study was conducted at Radiology and Imaging Department with active Gastrointestinal, Hepato-biliary and Pancreatic Disorders (GHRO) of BIRDEM, Shahbag, Dhaka, from July, 2011 to June, 2012.

Trans-abdominal ultrasonography of hepatobiliary system and spleen was carried out using Acuson computed sonography system with model 128 X p/4 multiple probes with multiple frequency, ranges from 2.5, 3.5, 4.5 and 7 MHz Siemens snoline-II, with 3.5 and 5 MHz probes and Tosbee from Toshiba company with 3.75 MHz Transducer. Frequency chosen from 4 MHz, 3.5 MHz and 2.5 MHz probes depending on physical built of the subjects.

All the subjects were evaluated by detailed history, relevant physical examination and findings of laboratory and oesophagoscopy examination. Before sonographic examinations, subjects were asked not to have nothing by mouth for 6 to 8 hours preceding the examination. They were positioned supine, and portal, splenic and superior mesenteric veins were imaged ultrasonographically. The portal vein was imaged in sagittal or right oblique scan at upper right

epigastrium, while the splenic and superior mesenteric veins were imaged in transverse and sagittal scan at epigastrium respectively. The diameters of portal, splenic and superior mesenteric veins were measured during breathing in the course of expiration and deep inspiration.

Result

An analytical cross-sectional study with 59 patients with portal hypertension as subjects and 45 normal subjects as controls was conducted to measure diameters of splenic, superior mesenteric and portal veins through transabdominal ultrasonography. Variation in diameters of those veins were compared during respiration of normal subjects and patients with portal hypertension. Findings of the study were as follows.

Regarding age distribution, it was observed that age range was from 22 to 79 years. Mean age of study subjects was 53.15 years with standard deviation of 11.44 years, whereas mean age of controls was 52 years with as standard deviation of 12.02 years. Among study subjects, 44 (74.58%) were male and 15 (25.42%) were female and among control 34 (75.56%) were male and 11 (24.44%) were female. Among study subjects portal veins were clearly visualized in cent per cent cases, while splenic vein in 53 (99.93%) and superior mesenteric vein in 49 (83.05%) cases. In contrast, among controls, portal vein was clearly visualized in cent per cent cases, while splenic vein in 42 (93.33%) and superior mesenteric vein in 38 (84.45%) cases (Fig-1).

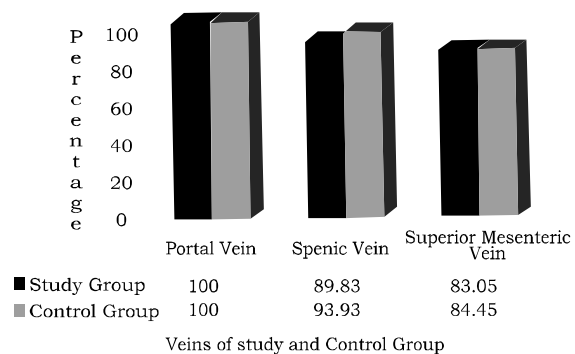


Fig-1: Multiple bar diagram showing status of visualization of different veins

In subjects with portal hypertension, it was revealed that during deep inspiration maximum diameters of portal, splenic and superior mesenteric veins were 9.2 to 17.0 mm 6.4 to 12.0 mm and 8.4 to 13.4 mm with mean diameters and standard deviation of 13.43 ± 1.76 mm, 9.29 ± 1.53 mm and 11.02 ± 1.17 mm respectively. Whereas among controls during deep inspiration

maximum diameters of portal, splenic and superior mesenteric veins were 7.5 to 15.0 mm, 3.7 to 9.2 mm and 4.3 to 11.4 mm with mean diameters and standard deviation of 11.19 ± 2.03 mm, 6.95 ± 1.75 mm and 8.77 ± 2.06 mm respectively. During deep inspiration, diameter of portal vein was greater than 13 mm in 31 (52.54%), while equal to or less than 13 mm in 28 (47.46%) of portal hypertensive cases. Out of 45 controls, in 8 (17.78%) cases, maximum diameter of portal vein was over 13 mm, while in 37 (82.22%) cases, diameter of portal vein was equal to or less than 13 mm

Among portal hypertensive subjects, in deep inspiration diameter of splenic and superior mesenteric veins in 18 (30.51%) and 42 (71.19%) cases were greater than 10 mm respectively (Table-I)

Table I

Ultrasonographic diameters of splenic and superior mesenteric veins in deep inspiration

Group	Splenic		Superior Mesenteric Vein	
	<10mm	>10mm	<10mm	>10mm
Controls	42(93.33)	0	25(55.55)	13(25.89)
Study	35(59.32)	18(30.51)	7(11.86)	42(71.19)

* Figures within parentheses indicate percentage

In all controls diameter variation of splenic and superior mesenteric veins during respiration was marked. Variation in diameter in the portal trunk was either very slight (< 10%) or totally absent. The mean diameter of splenic vein during deep inspiration was 6.95 mm with standard deviation 1.75 mm, whereas during expiration it was 4.45 mm and 1.24 mm respectively. The mean diameter of superior mesenteric vein during deep inspiration was 8.77 mm with standard deviation 2.06 mm, whereas during expiration it was 5.66 mm and 1.41 mm respectively. The difference in deep inspiratory and expiratory diameters was statistically highly significant ($p < 0.001$). Patients with portal hypertension diameter variation with breathing at the level of splenic and superior mesenteric veins observed only in 5 (8.47%) cases.

In addition to diameter measurements in portal vessels, ascites, liver and spleen were also evaluated ultrasonographically. Longitudinal measurement of liver in mid-clavicular line (size), surface regularity and parenchymal echo-texture of liver and spleen were observed.

Discussion

Transabdominal ultrasonography played a vital role in the diagnosis of portal hypertension. In controls, portal, splenic and superior mesenteric veins were visualized in 45 (100.00%), 42 (93.33%)

and 38 (84.45%) respectively. On the other hand, among 59 subjects with Portal hypertension, portal, splenic and superior mesenteric veins were visualized in 59 (100.00%), 53 (89.83%) and 49 (83.05%) subjects respectively. The ultrasonographic nonvisualization of splenic and superior mesenteric veins both in portal hypertensive subjects and normal individuals may be due to technically unsatisfactory scan as gas in the bowel obscuring the veins. Goyal et al. in 1990 revealed that portal, splenic and superior mesenteric veins were displayed on ultrasound in 100.00%, 98.00% and 96% of controls respectively, while in 100.00%, 92.00% and 82.00% subjects with portal hypertension.³

In all controls, diameters of portal, splenic and superior mesenteric veins were measured during deep inspiration and expiration. During deep inspiration, diameters of portal, splenic and superior mesenteric veins were from 7.5 mm to 15.0 mm, 3.7 to 9.2 mm and 4.3 to 11.4 mm with a mean and standard deviation of 11.19 ± 2.03 mm, 6.95 ± 1.75 mm and 9.77 ± 2.06 mm respectively. During deep inspiration mean and standard deviation of diameters of portal vein observed by Webb et al. was 6.3 ± 2.3 mm, by Weinreb et al. was 11.0 ± 2.0 mm by Goyal et al. was 10.4 ± 1.6 mm by Kuroi and Forsberg and was 11.5 ± 1.8 mm by findings of current study and supported by findings revealed by Weinreb et al.^{8,10}

Diameters of splenic and superior mesenteric veins were varied, increased during inspiration and decreased during expiration, significantly in all controls. Variation in diameters from expiration to inspiration were observed about 30 to 90 percent in splenic vein with a mean and standard deviation of 58.35 ± 15.58 mm, while in superior mesenteric vein it was from 30 to 85 per cent with a mean and standard deviation of 57.74 ± 14.80 mm. Kuroi and Forsberg opined that there was no established limits of respiratory variation in normal individuals.¹¹ However, a respiratory variation of less than 30 per cent in normal individuals should be considered pathological. Study findings are consistent with findings observed by Kuroi and Forsberg.¹¹

Diameter variation with respiration in normal subjects in portal trunk were observed very slightly less than 10 percent from expiration to inspiration, or completely absent. This has similarity with the findings observed by Weinreb et al and Bolondi et al. who revealed that unlike splenic and superior mesenteric veins, portal vein diameter does not alter significantly or no alteration with respiratory phases in normal individuals.^{7,10}

Subjects with portal hypertension, diameters of splenic and superior mesenteric veins remained unchanged or showed only slight variation (<10 percent) in most of the cases. Diameter variation was observed in only 5 (8.4%) cases. Increased pressure caused by descending diaphragm is not transmitted through non-elastic cirrhotic liver is the possible explanation of diminished respiratory variation.¹¹

In subjects with portal hypertension it was revealed that during inspiration diameter of portal vein was 9.2 to 17.0 mm with a mean of 13.43 mm and standard deviation of 1.76 mm. In 31 (52.54%) portal hypertensive subjects diameter of portal vein was more than 13.0 mm, while in 8 (17.78%) controls diameter of portal vein was over 13.0 mm. There is an increase of size of portal vein diameter with that of age.¹⁴ Kane and Katz in 1982, Weinreb et al. and Al-Nakshabani in 2006 observed that in portal hypertension with haemodynamically effective portosystemic shunts, the portal vein might remain small as much of the portal flow might be diverted through collaterals.^{10,12,13} There is also an increase of size of portal vein diameter with that of age.¹⁴ Although there is wide discrepancies in the upper normal values in the portal vein diameter, Weinreb et al. and Bolondi et al. reported that a portal vein diameter greater than 13.0 mm is a fair characteristic sign of portal hypertension.^{7,9}

Conclusion

Based on study findings it can be concluded that by evaluating the diminished response of splenic and superior mesenteric veins through transabdominal ultrasonography, diagnosis of portal hypertension can be made.

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