



Original Article

Characterization of Portal Vein and Other Abdominal Organs in Portal Hypertension Patients Using Ultrasound

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ABSTRACT

Portal hypertension occurs when the venous pressure increases in the portal vein due to some pathological changes such as liver cirrhosis, which results in an increased diameter of the portal and splenic vein. **Objective:** To assess and characterize the portal vein and other abdominal organs in portal hypertension patients using ultrasound to minimize the incidence of serious and life-threatening consequences of portal hypertension. **Methods:** A cross-sectional study with a sample size of 108 patients was carried out in five months, in a private hospital in Gujranwala. The subjects of age > 30 years were included with other considered variables such as gender, portal and splenic vein diameter, size, and characteristics pattern of the liver & spleen size with other abdominal complications. After taking informed written consent, patients were examined in a supine position using Mindray DC-3 Ultrasound Machine with a convex probe of 3.5 MHz's frequency. After collecting data, it was analyzed using SPSS version 20. **Results:** The study revealed that 73.1% of patients were predominantly male with a male-to-female ratio and the patients in age between 50 – 59 years were more afflicted with this condition. 51.9% of patients were diagnosed with moderate dilatation of the portal vein and severe splenic vein dilatation was seen in 36.1% of the patients. The liver size was reduced in 75% of patients. 35.2% of patients were diagnosed with grossly enlarged spleen while the other 65% of patients were with mild and moderate splenomegaly. In 87% of patients, normal liver echotexture was changed into a heterogeneous texture. Only 12% of patients were diagnosed with ascites and 27.8% with increased GB walls thickness. **Conclusions:** There was a notable link of portal hypertension with gender and age, as males of age between 50 – 59 years were commonly affected with this condition. Increased diameter of the portal and splenic vein, reduced liver size, splenomegaly, heterogeneous liver echotexture, ascites, and increased GB wall thickness were the common ultrasound findings in patients with portal hypertension.

INTRODUCTION

The liver receives the dual blood supply from the branches of the portal triad (portal vein, hepatic artery, and bile duct) [1]. The total amount of blood flow to the liver in one minute is approximately 1600ml; 1200ml (almost 75%) is supplied by the portal vein (formed by the unification of SMV and the SV) and other 400ml from the hepatic artery (an arm of the celiac trunk) [2]. It receives the remaining approximately 25% of the cardiac output [3]. The portal system is quirky in such a way that it does not directly drain into the venous system of the body or to the heart [4]. It consists of all the veins that transport blood from the gall bladder, pancreas, spleen, and abdominal section of the digestive system [5].

Branches of the portal triad enclosed in the sheath of the connective tissue makes the portal vein's wall echogenic on grayscale imaging that discriminates it from the hepatic vein, which has a wall that seems to be nearly undetectable [6]. The average length of the portal vein is approximately 8cm in an adult with a diameter that usually measures less than 13mm in AP dimension but it can alter during respiration [7]. When the diameter of the portal vein exceeds the upper limit it is considered portal hypertension [8]. The term portal hypertension can be explained as; the condition which occurs when the venous pressure within the portal system increases (normal range 1

- 4 mmHg) or the pressure of splenic vein exceeds 15 mmHg. The typical PV flow rate in normal people is 20 to 40 cm/sec, though the mean PV velocity in PHT (portal hypertension) patients might vary depending on the existence and location of the shunts [9]. Typically, the venous networks are smooth and normal blood flow in a portal system termed as hepatopetal (forward flow towards the liver) [10] but certain conditions such as structural changes, intrinsic liver disease, an obstruction may cause the smooth venous networks to become irregular which results in increased resistance of flow and blood started to flow in reversed direction termed as hepatofugal (reversed flow from the liver) [11]. This increased resistance causes the elevation of pressure within the portal veins which results in dilatation of the veins [12]. These abnormal and irregular flow patterns in the portal venous system result in the formation of collaterals and varicosities in the abdomen [13]. The portal system's pressure is influenced by two parameters: blood flow in the portal vein and liver resistance to outflow [14].

According to the Ohm's Law;

$P(\text{pressure}) = Q(\text{blood flow}) * R(\text{resistance})$

$PSP(\text{portal system's pressure}) = BFPV(\text{blood flow in portal vein}) * LROF(\text{Liver resistance to outflow})$ [15]

Based on anatomical locations, portal hypertension can be classified into three types; Pre hepatic PHT (increased blood pressure within the portal vein before entering the liver), Intrahepatic PHT (increased blood pressure within the portal vein inside the liver), Post-hepatic PHT (increased blood pressure within the atria, larger hepatic veins and caudal vena cava at the level of the heart) [16]. 90% of patients with portal hypertension fall into these three categories of intrahepatic PHT; presinusoidal PHT, sinusoidal PHT, and post sinusoidal PHT [17]. The commonest cause of portal hypertension is liver cirrhosis [18] which may usually result from post hepatitis B & C, alcohol-induced liver disease, cholestatic liver disease, or cystic fibrosis [19]. The late-stage portal hypertension can cause many complications such as splenomegaly, gastrointestinal hemorrhage, collaterals formation in the portal circulation, hepatic encephalopathy, ascites, esophageal varices, hepatorenal syndrome, and death [20,21]. Non-invasive ultrasound is used most frequently as the first-line examination for the evaluation of patients with PHT as it is a simple and inexpensive medical imaging technique that uses high-frequency sound waves to assess and characterize the liver to make an accurate diagnosis [22]. Usually, based on physical examination, patients with splenomegaly and ascites are suspected to have PHT, [23] but this diagnosis can be confirmed on the grayscale imaging by assessing abdominal organs, [24] as results of the grayscale ultrasound are generally quite specific and

can be used to confirm a diagnosis. Ultrasound plays a crucial role to evaluate cirrhosis and periportal fibrosis in patients with portal hypertension, [25] determining the diameter of the vessels and the size of the spleen, as well as the presence of ascites and an irregular collateral route. The goal of the current study is to aid in controlling the severity of portal hypertension, preventing complications by diagnosing it early, and lowering the rate of morbidity, mortality, and risk factors of PHT by evaluating the liver and spleen morphological characteristics in addition to the parameters of the portal and splenic vein in the PHT patients using ultrasound because it is a useful and reliable modality in radiology, as compared with other modalities.

METHODS

The cross-sectional study was carried out in five months in the Ultrasound Department of a private hospital in Gujranwala. The sample size of 108 patients was calculated via a convenient sampling approach using a mean value from previous studies [3,6,20]. The trans-abdominal scan was performed using Mindray DC-3 Ultrasound Machine with a convex probe of frequency of 3.5 MHz's. After taking informed written consent, patients were examined on both short and long axis in a supine position after applying a small amount of ultrasound gel in the epigastrium region. The age, gender, portal, splenic vein diameter, size, and echotexture of liver and spleen size with other abdominal complications were all considered variables. The data was collected on a data collection excel sheet. After collecting the data, it was analyzed using computer SPSS version 20 (Statistical Package for the Social Sciences) software.

RESULTS

The following frequency distribution tables were formulated to show the response of each respondent and to describe the link between the variables based on their condition. Table 1 shows that there was a definitive link between gender and portal hypertension. Males 79 (73.1%) were more likely to develop portal hypertension than females 29 (26.9%). Table 2 shows that the risk of developing portal hypertension increases in middle age (50 - 59 years) and decreases gradually after this particular age group.

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	29	26.9	26.9
	Male	79	73.1	73.1
	Total	108	100.0	100.0

Table 1: Frequency Distribution of The Respondent's Gender.

Age Group (yrs)	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30 - 39	23	21.3	21.3
	40 - 49	32	29.6	29.6
	50 - 59	34	31.5	31.5
	60 - 69	17	15.7	15.7
	70 - 79	2	1.9	1.9
	Total	108	100.0	100.0

Table 2: Frequency Distribution of Respondent's Age in Groups

Table 3 shows that 56 (51.9%) patients had moderate while 36 (33.3%) were mild and 16 (14.8%) had severe portal vein dilatation. It also shows that PHT affects the splenic vein in the same way as the portal vein, 39 (36.1%) patients were diagnosed with severe while 37 (34.3%) with mild and other 32 (29.6%) with moderate splenic vein dilatation. The liver size was reduced in 81 (75%) patients while the remaining 11 (10.2%) patients were falling into enlarged and 16 (14.8%) normal size groups. Table 3 shows that in PHT patients, splenomegaly was the common complication as 38 (35.2%) patients were diagnosed with grossly enlarged spleen while the other 36 (33.3%) patients were mild and 34 (31.5%) with moderate splenomegaly. This table also shows that in 94 (87%) patients normal liver echotexture was changed into coarse texture and in 95 (88%) patients there were no significant ascites while other 13 (12%) patients were diagnosed with abdominal, pelvic, or abdominopelvic ascites. Table 3 also shows that in 30 (27.8%) cases the thickness of GB walls was increased though 78 (72.2%) patients were with normal GB wall thickness.

Finding	Variables	Frequency	Percent
Portal vein dilatation	Mild	36	33.3
	Moderate	56	51.9
	Severe	16	14.8
	Total	108	100.0
Splenic Vein Dilatation	Mild	37	34.3
	Moderate	32	29.6
	Severe	39	36.1
	Total	108	100.0
Liver Size	Enlarged	11	10.2
	Normal	16	14.8
	Small	81	75.0
	Total	108	100.0
Splenomegaly	Mild	36	33.3
	Moderate	34	31.5
	Severe	38	35.2
	Total	108	100.0
Sonographic Appearance of Liver	Normal	14	13.0
	Coarse	94	87.0
	Total	108	100.0
Ascites	Yes	13	12.0
	No	95	88.0
	Total	108	100.0
Gall Bladder Wall Thickness	Yes	30	27.8
	No	78	72.2
	Total	108	100.0

Table 3: Ultrasound Findings in Patients with Portal Hypertension

DISCUSSION

Ultrasonography is now a frequently used imaging technique in healthcare settings to evaluate patients with

portal hypertension as it is a very useful and reliable method for determining the causes and adverse outcomes of portal hypertension. The current cross-sectional study was carried out in five months in the Ultrasound Department of a private hospital in Gujranwala with a sample size of 108 patients with portal hypertension and other considered variables were gender, age, portal, and splenic vein measurements, liver and spleen size, echotexture of the liver, presence of ascites and increased GB walls thickness. The current study findings revealed that there was a strong correlation between gender and portal hypertension, 79 patients were predominantly male, with a 73.1% male-to-female ratio, and this record also supports Alhabeib (2018) [20] point of view. Ibrahim (2019) who studied abdominal organs characterization in patients with portal hypertension also found out that the male gender has a higher incidence of developing portal hypertension than the female gender [6]. The current study results disclosed that people in the middle age group 50 – 59 years were at higher risk to develop portal hypertension while people of age between 40 – 49 years were on the second number to be affected with this condition, but the risk of developing portal hypertension was less before and after this particular age group, this point of current study resembled with the Babeker's study (2019) [3]. As for checking the effect of portal hypertension on the portal and splenic vein width, the current study formulated 3 groups as mild, moderate, and severe vein dilatation, results revealed that most of the patients fell in the second group 'Moderate Dilatation' in case of portal vein width with the percentage of 51.9% while in respect to splenic vein width most of the patients fell in the group of severe dilatation with 36.1 percentage, alike Babeker's study (2019) [3]. The current study found that the liver size of 75% of patients was reduced due to liver cirrhosis which is the commonest cause of portal hypertension while the other 25% of patients had normal and enlarged sized liver categories, similar to Ibrahim's (2019) study findings [6]. Splenomegaly was the common complication in patients with portal hypertension as 35.2% of patients were diagnosed with a grossly enlarged spleen, on the other hand, 65% of patients had mild and moderate splenomegaly, which was also found by Babeker (2019). Changed normal liver echotexture in patients with portal hypertension was the common ultrasound finding as in 87% of patients the normal echotexture of the liver was lost and turned into a coarse texture, similar was said by Ibrahim (2019) and Alhabeib (2018). Other common abdominal complications in portal hypertension patients were the ascites and increased GB walls thickness that was disclosed by the current study as 12% of patients were diagnosed with abdominal, pelvic, or abdominopelvic

ascites and 27.8% were diagnosed with increased GB walls thickness. These common abdominal complications in portal hypertension patients were also discussed by Babeker(2019)and Alhabeib(2018)[3,20].

CONCLUSIONS

In conclusion, ultrasonography has proven to be quite a useful and reliable modality in the evaluation of patients with portal hypertension. The current study found that there is a notable link of portal hypertension with gender and age, as males of age between 50 – 59 years were commonly affected by this condition. The diameter of the portal and a splenic vein was increased due to increased venous pressure, which may be caused due to hepatic diseases. Reduced liver size and increased spleen size were the common ultrasound findings in portal hypertension patients. The change of normal liver echotexture to coarse texture was not unusual in this condition. The ascites and increased GB walls thickness were also seen in some cases.

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