

Doppler Assessment of Main Portal Vein Among Apparently Normal Population in District Multan

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Abstract:

Portal Vein (PV) is a type of blood vessel that takes blood from gestational tract, gallbladder, pancreas and spleen to the liver. The liver receives its blood through PV. Portal vein ascends obliquely to the right in permitted margin of small omentum, originating behind the back of Pancreas.

Objective:

To access the main Portal Vein by Doppler ultrasound among apparently normal population in district Multan.

Methods:

The descriptive cross-sectional study was conducted at Tariq Ultrasound Center Multan. Samples were chosen by convenient sampling technique. Total 384 healthy individuals aged between 20-50 were included in current study. Patients with known history of diseases were excluded from the study. GE S6 Japan, with convex probe was used for ultrasound scanning and measurements. The Doppler study was performed by using duplex and triplex features. A semi-structure questionnaire was used for data collection. SPSS Version 21 was used for data analysis. The mean \pm S.D was calculated for quantitative data and percentage was calculated for qualitative data.

Results:

The average age of participant's was 35.08 ± 8.935 years. The mean PV Diameter of patients were 12.73 ± 8.935 mm. The mean PSV of PV Diameter of patients was 30.04 ± 5.190 mm. The mean PV Diameter (mm) of females was 11 ± 0.2 and males were 13 ± 1.2 . There was no gender wise association between mean diameter of portal vein assessed, as p-value is greater than 0.05.

Conclusions:

It was concluded from the current study that the

mean portal vein diameter was very important in human system. This study has established baseline values for normal range of portal vein diameter in apparently healthy adults in a Multan population to be 12.38 ± 1.371 mm.

Keywords:

Portal Vein, Velocity of PV, Normal Population, Ultrasound, PV thickness

Introduction:

PV is formed Subsequent to the neck of pancreas by the union of superior mesenteric vein and splenic vein at the level of L2. PV ascends obliquely to the right in free margin of lesser omentum, passing behind superior part of duodenum hepatic artery, CBD, and anterior to the inferior vena cava. PV enters from the right side of portal hepatic where it splits into right and left branches. Its trunk is 5-8 cm in length and its normal diameter is between 9mm-13mm portal vein is responsible for 70-80% of liver's blood supply the remaining 20-30% of blood is supplied by hepatic artery. The portal flow and diameter varies with age of the patient, gender and weight. These parameters are also affected in the various pathological conditions, such as, portal hypertension which leads to liver disease, compression of portal vein, congestive cardiac failure, constrictive pericarditis, congenital anomalies, thrombosis, trauma, and neoplastic abnormalities etc.¹

The art of scanning demands a lot from the sonographer, it includes the extraordinary skill of hand-eye coordination, the capability to describe two dimensional information into three dimensional layout, and a detailed consideration of anatomy, physiology, pathology, equipment, artifact production and transducer characteristic. Sonologist should also be aware of how Doppler technique, color flow mapping and

three dimensional imaging have enhanced modern medicine's understanding of anatomy and physiology as it relates to blood-flow dynamics and reconstruction.²

For measurement of PV diameter, the central portion of the cursors was fixed at the echogenic outer wall of the vein. Hepatic Arterial (HA) resistance index pulsatility index (PI), peak systolic velocity (PSV) and end-diastolic velocity (EDV) were measured at the hepatic hilum.³ A lack of overlap exists between the finding of a PV outward flow lasting more than 500 ms and the net outward flow of the same vessel.⁴ Doppler ultrasound is an essential tool for the assessment of portal flow and also an important instrument for the diagnosis of patients with high risk for Acute Kidney Injury (AKI) due to cardiogenic venous congestion.^{5,6}

Prior Transarterial Chemoembolization (TACE) the determination of PV flow may be helpful in borderline cases considered for TACE. Retrograde PV flow alone was insignificant prognostic marker, but patients advanced liver cirrhosis treated with (TACE) and retrograde PV flow had a minimum survival.⁷ Increased resistance to portal blood flow causes portal hypertension which is responsible for different complications such as variceal bleeding and ascites.⁸ Surgical treatment of variceal hemorrhagic complications for patients with schistosomal portal hypertension in our group comprised an esophagogastric devascularization procedure with splenectomy (EGDS).⁹ Increased Doppler impedance and acceleration indices have been described in the hepatic and splenic arteries in portal hypertension. A study conducted by Piscaglia, et al., reported that "splenic artery resistant index (RI) and the portal hypertension index [(hepatic artery RI \times 0.69) \times (splenic artery RI \times 0.89)], have the maximum precision in the identification of portal hypertension".¹⁰

In another study by Rokni *et al.*, represent that reduction in the expected normal increase in the diameter of portal and splenic veins, in response to deep inspiration have high sensitivity and

specificity for diagnosis of cirrhosis, regardless of the portal pressure.¹¹ The HA and PV parameters, can not only be used to detect portal hypertension, but also can be used to evaluate the hemodynamic changes in alcoholic patients. Cosar, *et al.*, compared 30 alcoholic patients having no signs of hepatic damage and 30 control subjects. PV cross-sectional area was greater in alcoholic patients than the healthy control group (P value, 0.0012). PV velocity (P value, 0.0001), HA peak systolic velocity (PSV), (P value, 0.0005) and end-diastolic velocity (EDV), (P value, 0.0001), superior mesenteric artery peak systolic (P value, 0.0060) and end-diastolic velocity (P value, 0.0099) were all significantly greater in alcoholic patients than in the control group.¹² Bozgeyik Z *et al.*, (2009) stated the Hepatic and portal venous Doppler waveforms and flow velocities in normal pregnancy. Maximum flow velocity of PV was higher in group 1 than in groups 2 and 3 ($p < 0.05$). Although some subjects had a monophasic flow pattern of the PV, a biphasic flow pattern was prominent in all groups. A triphasic PV waveform was not observed in any of the groups. In the HV the triphasic waveform was prominent in the first trimester and biphasic in the second and third trimesters. When evaluating physiological changes in pregnancy, flow pattern changes of the HV and flow velocity changes of the PV may be accepted as sensitive parameters and may be indicators of physiological alterations related to pregnancy.¹³ Dageforde *et al.*, (2015) stated the increased minimum vein diameter on preoperative mapping with duplex ultrasound is associated with arteriovenous fistula maturation and secondary patency. The sample included 158 adults (54 ± 14 years; 45% male; 61% white; 56% diabetes; body mass index, 32 ± 8 ; MVD, 3.4 ± 1.1 mm; follow-up, 12 ± 9 months [range, <1-40 months]). Increased MVD was associated with decreased risk of AVF failure.¹⁴ Gaeun *et al.*, (2015) stated the The Accuracy of Ultrasonography for the Evaluation of Portal Hypertension in Patients with Cirrhosis: A Systematic Review. A total of 14 studies met

our inclusion criteria. The US indices were obtained in the portal vein ($n = 9$), hepatic artery ($n = 6$), hepatic vein (HV) ($n = 4$) and other vessels. Using hepatic venous pressure gradient (HVPG) as the reference, the sensitivity (Se) and specificity (Sp) of the portal venous indices were 69-88% and 67-75%, respectively.¹⁵

The status of Main Portal Vein in normal individuals by Doppler was assessed so that abnormalities may be determined for early treatment.

Methods:

The descriptive cross-sectional study was conducted at Tariq Ultrasound Center Multan. Samples were chosen by convenient sampling technique. Total 384 healthy individuals aged between 20-50 years were included. Patients with known history of diseases were excluded from the study. GE S6 Japan, and a convex probe were used for ultrasound scanning and measurements. The Doppler study was performed by using duplex and triplex features. A semi-structure questionnaire was used for data collection. Analysis of data was conducted by using SPSS version 21. Mean \pm S.D was calculated for quantitative data and percentage was calculated for qualitative data.

Results:

The minimum age of patients was 20 and maximum was 50. The average age of participants were 35.08 ± 8.935 . The minimum and maximum PV Diameter was 9 and 14 respectively. The mean PV Diameter of patients were 12.73 ± 8.935 mm. The minimum and maximum PSV of PV Diameter of patients were 20 and 40 respectively. The mean PSV of PV Diameter of patients were 30.04 ± 5.190 mm, as shown in Table 1.

Variables	Minimum	Maximum	Mean \pm SD
Age	20	50	35.08 ± 8.9
PV Diameter(mm)	9	14	12.73 ± 0.9
PSV of Pv(cm/sec)	20	40	30.04 ± 5.2

Table 1: Descriptive statistics of age, PV Diameter and PSV of PV

The descriptive statistics of patient's PV Diameter (mm) with respect to gender were

shown in Table 2. The mean PV Diameter (mm) of females were 11 ± 0.2 and males were 13 ± 1.2 .

PV Diameter(mm)	Gender of Patients	
	Female	Male
	Mean \pm SD	Mean \pm SD
	11 ± 0.2	13 ± 1.2

Table 2: Descriptive Statistics of PV Diameter (mm) with respect to Gender

The mean difference of portal vein between genders were described in Table 3. In females the average diameter of PV was $12.78 \pm .963$ and in males were $12.68 \pm .986$ respectively (P-value < 0.05).

Gender of Patients		n	Mean \pm SD	t	p-Value
PV Diameter	Female	202	$12.78 \pm .963$	1.069	0.286
	Male	182	$12.68 \pm .986$	1.067	

Table 3: Mean Difference of Portal vein in Gender

Discussion:

A clinical review conducted by Handa P 2014, reported that as in improvements in modern techniques like CT, MRI and Ultrasound Doppler has increased the diagnosis of portal vein thrombosis (PVT). The PVT has clinical problem that have become life-threatening situation. It is associated with several diseases like cirrhosis, abdominal malignancies and prothrombotic disorders. It is very difficult for the clinicians to decide whether PVT is chronic or acute, so that its management become more difficult. It leads to different management strategies like anticoagulants, thrombolysis and surgical options.¹⁶ These finding were also similar to current study which leads to the assessment of portal vein by US so that timely diagnosis of disease should be established so that it could not lead to serious problem.

The minimum and maximum age of patients was 20 and 50 years respectively. The mean age of participants were 35.08 ± 8.9 . The minimum and maximum PV Diameter of patients were 9 and 14 respectively. The mean PV Diameter of patients were 12.73 ± 8.9 mm. The minimum and

maximum PSV of PV Diameter of patients were 20 and 40 respectively. The mean PSV of PV diameter of patients was 30.04 ± 5.2 mm.

A study conducted in Northern Nigerian population during 2016 showed that the diameter of PV was 9.60 ± 1.4 mm. The mean value for males was 9.71 ± 1.42 mm and 9.35 ± 1.46 mm among females.¹⁷

In another study conducted on healthy individuals of Nigerian adults reported the average diameter of PV was 10.3 ± 1.5 mm. in males PV diameter was 10.5 ± 1.5 mm and females it was 10.2 ± 1.5 mm.¹⁸

In a study conducted by Kratzer W *et al.*, on the sonographic measurements of the Normal Liver, spleen, pancreas and portal vein showed that total 1000 consecutive blood donors enrolled in the study among which there were 160 women and 840 men aged between 18-65 years. All the patients were examined thorough US. The results of the study showed that the maximum diameter of the portal vein in cm were 1.2 ± 0.2 and the width of PV at the porta hepatis existed 1.0 ± 0.2 .¹⁹ These findings were similar to the current study.

In a study conducted by Weinreb J *et al.*, on Portal Vein Measurement showed that patients who are diagnosed by Ultrasonography and met the inclusion criteria with age group 21-40 years have mean portal diameter was 11 ± 2 mm which has also accordance with the current study.²⁰

In another study on congestion Index of the portal Vein showed that they studied total 85 normal subjects. Out of other 221 from which 11 patients were with acute hepatitis, 42 with chronic, 72 with Cirrhosis and 11 with idiopathic portal hypertension. The results showed that the blood flow velocity (cm/sec) was 15.3 ± 4.0 in normal or healthy population²¹. These Findings were also in accordance to the current study.

A study on the normal portal vein diameter in children was conducted which showed that at the time of birth the size of portal vein was 3-5, at one years it was 4-8 and at 5 years of age it was 6-8 increases. It was also reported that there was little difference between in the diameter of PV in

boys and girls²². But these results were not similar to current study as there is no significant difference observed in gender.

Conclusions:

It was concluded from the current study that the mean portal vein diameter was very important in human system. This study has established baseline values for normal range of portal vein diameter in apparently healthy adults in a Multan population to be 12.38 ± 1.371 mm.

References:

- 1- Zwiebel WJ. Vascular disorders of the liver in Zwiebel WJ. Introduction to vascular ultrasonography. 4th ed. Philadelphia: W.B Saunders; 2015: 431-443.
- 2- Paul Allen Clinical Doppler Ultrasound, 2nd edition by 2016
- 3- Giancesini S, Menegatti E, Sisini F, Occhionorelli S, Annoni F, Lee BB, Zamboni P. Comparison Between Duplex Ultrasound and Multigate Quality Doppler Profile Software in the Assessment of Lower Limb Perforating Vein Direction. European Journal of Vascular and Endovascular Surgery. 2018 May 1;55(5):688-93.
- 4- Gölbaşı Z, Çağlı K, Özeke Ö, Aras D. How to image individual pulmonary veins with transthoracic echocardiography. Anatolian journal of cardiology. 2017 Oct;18(4):304-308.
- 5- Keegan J, Raphael CE, Parker K, Simpson RM, Strain S, de Silva R, Di Mario C, Collinson J, Stables RH, Wage R, Drivas P. Validation of high temporal resolution spiral phase velocity mapping of temporal patterns of left and right coronary artery blood flow against Doppler guidewire. Journal of Cardiovascular Magnetic Resonance. 2015 Dec;17(1):85-93.
- 6- Kirstein MM, Voigtländer T, Schweitzer N, Gebel M, Hinrichs JB, Rodt T, et al. Retrograde portal vein flow and transarterial chemoembolization in patients with hepatocellular carcinoma-a case-control study. Scandinavian journal of

- gastroenterology. 2017 Dec 2;52(12):1398-406.
- 7- Denault AY, Beaubien-Souligny W, Elmi-Sarabi M, Eljaiek R, El-Hamamsy I, Lamarche Y, Chronopoulos A, Lambert J, Bouchard J, Desjardins G. Clinical significance of portal hypertension diagnosed with bedside ultrasound after cardiac surgery. *Anesthesia & Analgesia*. 2017 Apr 1;124(4):1109-15.
 - 8- Martínez-Noguera A, Montserrat E, Torrubia S, Villalba J. Doppler in hepatic cirrhosis and chronic hepatitis. In *Seminars in Ultrasound, CT and MRI* 2002 Feb 1 (Vol. 23, No. 1, pp. 19-36). WB Saunders.
 - 9- Ferreira FG, Ribeiro MA, de Fátima Santos M, Assef JC, Szutan LA. Doppler ultrasound could predict varices progression and rebleeding after portal hypertension surgery: lessons from 146 EGDS and 10 years of follow-up. *World journal of surgery*. 2009 Oct 1;33(10):2136-43.
 - 10- Piscaglia F, Donati G, Serra C, Muratori R, Solmi L, Gaiani S, et al. Value of splanchnic Doppler ultrasound in the diagnosis of portal hypertension. *Ultrasound in medicine & biology*. 2001 Jul 1;27(7):893-9.
 - 11- Yasu JP, Rocher L, Peletier G, Kuoch V, Kulh E, Miquel A et al. He-patic venous pressure gradients measured by duplex ultrasound. *ClinRadiol* 2013;57:746-752
 - 12- Rokni H and Sotoudeh H. Assessment of Normal Doppler Parameters of Portal Vein and Hepatic Artery in 37 Healthy Iranian Volunteers. *Iran J Radiol* 2006;4: 213-216
 - 13- Bozgeyik Z, Ozdemir H, Kocakoc E, Simsek M. Hepatic and portal venous Doppler waveforms and flow velocities in normal pregnancy. *Medical Science Monitor*. 2009 Dec 1;15(12):CR624-7.
 - 14- Dageforde LA, Harms KA, Feurer ID, Shaffer D. Increased minimum vein diameter on preoperative mapping with duplex ultrasound is associated with arteriovenous fistula maturation and secondary patency. *Journal of vascular surgery*. 2015 Jan 1;61(1):170-6.
 - 15- Kim G, Cho YZ, Baik SK, Kim MY, Hong WK, Kwon SO. The accuracy of ultrasonography for the evaluation of portal hypertension in patients with cirrhosis: a systematic review. *Korean journal of radiology*. 2015 Apr 1;16(2):314-24.
 - 16- Handa P, Crowther M, Douketis JD. Portal vein thrombosis: a clinician-oriented and practical review. *Clinical and Applied Thrombosis/Hemostasis*. 2014 Jul;20(5):498-506.
 - 17- Luntsi G, Sani M, Zira JD, Ivor NC, Garba SH. Sonographic assessment of the portal vein diameter in apparently healthy adults in a northern Nigerian population. *African health sciences*. 2016;16(4):1163-8.
 - 18- Adeyekun AA, Tsebi HB. Grey-scale sonographic evaluation of portal vein diameter in healthy Nigerian adults. *Journal of Medicine and Biomedical Research*. 2014;13(1):17-24.
 - 19- Kratzer W, Fritz V, Mason RA, Haenle MM, Kaechele V, Roemerstein Study Group. Factors affecting liver size: a sonographic survey of 2080 subjects. *Journal of ultrasound in medicine*. 2003 Nov;22(11):1155-61.
 - 20- Weinreb J, Kumari S, Phillips G, Pochaczewsky R. Portal vein measurements by real-time sonography. *American Journal of Roentgenology*. 1982 Sep 1;139(3):497-9.
 - 21- Annet L, Materne R, Danse E, Jamart J, Horsmans Y, Van Beers BE. Hepatic flow parameters measured with MR imaging and Doppler US: correlations with degree of cirrhosis and portal hypertension. *Radiology*. 2003 Nov;229(2):409-14.
 - 22- Corness JA, McHugh K, Roebuck DJ, Taylor AM. The portal vein in children: radiological review of congenital anomalies and acquired abnormalities. *Pediatric radiology*. 2006 Feb 1;36(2):87-96.