

# Gender Linked Metric Analysis of Portal Vein: A Sonographic Appraisal

SHIKHA SINGH<sup>1</sup>, ARVIND KUMAR PANKA<sup>2</sup>, ANITA RANI<sup>3</sup>, PRADEEP KUMAR SHARMA<sup>4</sup>, PUJA CHAUHAN<sup>5</sup>

## ABSTRACT

**Introduction:** Portal hypertension is one of the most mystifying and disconcerting abdominal ailment. Ultrasonography (USG) is an effective diagnostic tool for its prompt management. Knowledge of normal calibre of portal vein in a local setting is essential as literature reports contrasting values in different regions. It helps in early diagnosis of portal hypertension even before it is clinically manifested thereby assisting clinicians and interventional radiologists in pertinent management.

**Aim:** Study was aimed to evaluate the Portal Vein Diameter (PVD) and find its correlation with gender by using USG in North Indian population.

**Materials and Methods:** A total of 300 healthy adults were included in the study. Portal vein diameter was measured in supine

position and normal respiration by grey scale USG. The portal vein diameter was correlated with age and gender statistically using independent Student's t-test and ANOVA.

**Results:** Mean PVD of (9.49±1.03 mm) was observed in the present cross-sectional study. Male showed a significantly higher mean PVD (9.70±1.02 mm) as compared to females (9.10±0.94 mm).

**Conclusion:** Scarcity of information concerning ultrasonographically measured standard portal vein diameter and inconstant values reported in literature necessitates the need for establishing local standard value. In the given subset of population the portal vein diameter was influenced by the gender. The information will be helpful in prompt diagnosis and management of portal hypertension.

**Keywords:** Correlation, Portal hypertension, Portal vein morphometry, Radiological

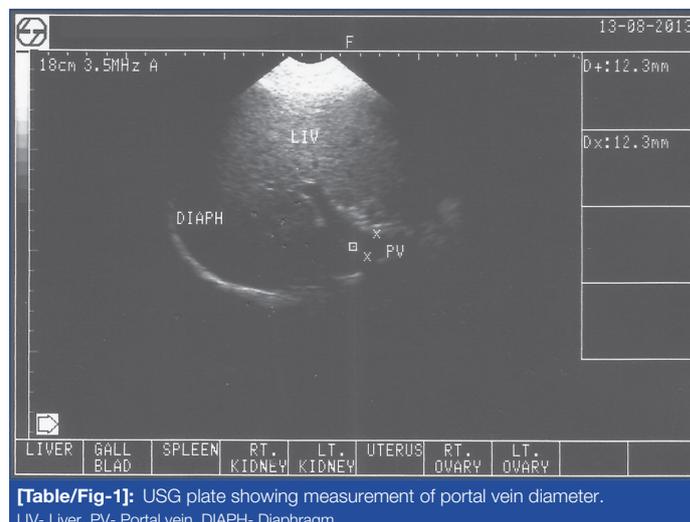
## INTRODUCTION

Portal vein drains the blood from the abdominal part of the alimentary tract except the lower part of rectum and anal canal as well as the spleen, pancreas, and gall bladder [1]. It forms vital anastomoses with oesophageal, rectal venous plexus and superficial veins of the abdomen. Portal venous blood has slightly higher pressure (5-10 mmHg) than systemic veins. Ailments affecting the portal venous system usually appear as portal hypertension [2]. This leads to broadening of extra hepatic and intrahepatic portal vessels and formation of spontaneous portosystemic collateral channels [3].

USG is an effective diagnostic tool in the diagnosis and follow up of patients with portal vein abnormalities [4]. Yet radiological assessment of PVD vis-à-vis USG finds rare mention in available literature in North Indian population. It is reported only in Maharashtra [5] Rajasthan [6] and North East India [7] where mean diameter is found to be 9.20 mm, 10.5 mm and 8.83 mm respectively. There are some recent studies in the Iranian region [8] which have parallel findings and few deviations from the present study which include those in Ethiopian [9] and Chinese population [10]. An effort was also made to find correlation with age and sex. Gender linked assessment of diameter in many populations across world showed results in which PVD in males was greater than PVD females [7,8,11,12] except in few studies [9,13-15]. Correlation of PVD with age showed a proportionate trend between the two in few studies [9,13-16] whereas few others revealed absence of any such association [7]. Thus, the possibility of association of PVD with age and gender and its variability from one population to other cannot be underestimated. Hence, the current study was undertaken to establish correlation between PVD with age and gender in local (North Indian) population.

## MATERIALS AND METHODS

The present prospective observational study was conducted in Department of Anatomy at King George's Medical College, Lucknow, Uttar Pradesh, India, from January 2013 to November 2013. The study included 300 subjects (M=198 and F=102) who were young healthy adults belonging to Eastern province of Uttar Pradesh region. Subjects with history of infective hepatitis, jaundice, blood transfusion, haematemesis, malena, confusion, forgetfulness, schistosomiasis, presence of lower limb oedema, spider nevi, and caput medusa were excluded. After obtaining consent and proper ethical clearance, all the subjects between 18-29 years of age were picked at random from the medical students, residents and employees working in the Department of Anatomy and were



**[Table/Fig-1]:** USG plate showing measurement of portal vein diameter. LIV- Liver, PV- Portal vein, DIAPH- Diaphragm

assessed in the morning after an overnight fasting in supine position. For measurement of portal vein diameter, a 3.5 MHZ transducer was placed transversely at epigastric region with slight adjustment. When visualization was optimum, measurement of the portal vein diameter was taken in quiet respiration just before its entry into the liver. Measurements were obtained lumen to lumen and in mm [Table/Fig-1].

The demographic profile of the subject enrolled in the study has been shown in [Table/Fig-2].

### STATISTICAL ANALYSIS

Statistical analysis was done through SPSS (Statistical Package for Social Sciences) Version 15.0 statistical analysis software using Students t-test for independent groups and ANOVA.

### RESULTS

PVD measurements ranged from 7.0 to 12.6 mm. Mean PVD measurement, standard deviation and median value were 9.495, 1.03 and 9.40 mm respectively. After trimming the 5% of terminal data the normative range representing 95% of study population could be proposed between 9.38 and 9.61.

#### Association Between Gender and PVD

Males had significantly higher mean PVD values (9.70±1.02 mm) as compared to females (9.10±0.94 mm) [Table/Fig-3].

#### Association Between Age and PVD

Mean PVD was maximum in age group 21-25 years and minimum in age group 26-30 years. Statistically, a significant difference in mean PVD among different age groups was observed (F=3.328; p=0.037). On evaluating the data further, mean difference between age group 21-25 years and 26-30 years was found to be maximum (0.46±0.18) while the same between ≤20 years and 21-25 years was found to be minimum (0.20±0.13). Statistically, the difference was found to be significant only for 21-25 and 26-30 years age groups (p=0.013) [Table/Fig-4].

The pattern of differences in mean PVD values suggested existence of a non-linear association between PVD values and age.

For all the age groups males had significantly larger mean PVD (p<0.05) but within gender no significant effect on mean PVD was observed for increasing age (p>0.05). The correlation between age and portal vein diameter was inverse and weak in nature (r<0.3) for both the genders and was statistically significant only among females (p=0.018). Proportionally, there was a significant difference in gender wise distribution of volunteers in two groups with females being confined to lower age group only [Table/Fig-5].

Characteristic	No. of subjects	%	Male (n=198) 66 %		Female (n=102) 34 %	
			No.	%	No	%
≤20 Years	133	44.3	66	33.33	67	65.7
21-25 Years	128	42.7	110	55.56	18	17.6
26-30 Years	39	13.0	22	11.11	17	16.7
Mean Age±SD (Range)	21.70±2.81(18-30)		21.97±2.51(18-29)		21.16±3.25(18-30)	
$\chi^2=40.17$ (df=2); p<0.001						

[Table/Fig-2]: Demographic characteristics of study subjects.

SN	Gender	N	Mean PVD	SD	Min	Max	95% Confidence intervals		Difference		Statistical Significance	
							Lower	Upper	Mean	SE		
1.	Male	198	9.70	1.02	7.00	12.60	9.55	9.84	0.59	0.12	4.879	<0.001
2.	Female	102	9.10	0.94	7.30	11.50	8.92	9.29				

[Table/Fig-3]: Association between gender and PVD measurements. t=4.879; p<0.001

SN	Age Group (yrs)	Total	Mean	Mean Difference	Statistical Significance	
					SE	"p"
1.	≤20	133	9.44±1.06	-0.20	0.13	0.128
2.	21-25	128	9.64±1.08	0.26	0.18	0.151
3.	26-30	39	9.18±0.66	0.46	0.18	0.013

[Table/Fig-4]: Comparison of mean PVD for different age group.

SN	Age group (yrs)	Males		Females		Difference		Statistical Significance	
		N	Mean±SD	N	Mean±SD	Mean	SE	"t"	"p"
1.	≤20	66	9.64±1.08	67	9.25±1.00	0.39	0.18	2.157	0.033
2.	21-25	110	9.77±1.06	18	8.89±0.90	0.88	0.23	3.749	0.001
3.	26-30	22	9.51±0.51	17	8.77±0.60	0.81	0.18	4.590	<0.001
Among age group differences (ANOVA)		F=0.209; p=0.466 (r=-0.234; p=0.018)		Male vs female proportional representation in different age groups $\chi^2=40.17$ (df=2); p<0.001					

[Table/Fig-5]: Comparison of mean PVD between two genders for different age group.

Author	Year	Countries/Continent	Sample Size	Diameter (mm)
Arjmand SA et al., [12]	2001	Iran	43	9.60
Tasu JP et al., [19]	2002	-	30	11.0
Ongoiba N et al., [20]	2003	Africa	60	9.16
Yazdi HR and Kalilian MR [21]	2005	Iran	36	8.9
Chuo LS et al., [10]	2005	Malaysia,China, India	48	14.5
Sudhamshu KC [22]	2006	Japan	60	8.9
Yazdi HR and Sotoudeh H [8]	2006	Iran	37	9.36
Adibi A and Givechian B [23]	2007	Iran	375	9.75
Anakwue AC [15]	2009	Nigerian	200	11.4
Hawaz Y et al., [9]	2012	Ethopia	502	7.9
Siddiqui TR et al., [14]	2014	Pakistan	459	9
Present study		India	300	9.5

[Table/Fig-6]: Comparison of PVD from various parts of the world [8-10, 12, 14, 15, 19-23].

### DISCUSSION

Defining a normal range of portal vein calibre for a given subset of population is essential as portal hypertension can be identified even before it is clinically manifested by measuring its diameter. In late phase of portal hypertension, the diameter measurement is not reliable due to the development of portosystemic shunts which deflates the pressure in portal vein. An affirmative correlation is seen between the severity of portal hypertension and sonographically measured PVD [17].

Normally PVD varies between 7 mm to 15 mm [18]. Present cross-sectional study concluded the mean PVD to be 9.49±1.03 mm whereas, studies conducted by Khandare V et al., Goyal AK et al., and Saha N et al., in Maharashtrian, Rajasthani and North eastern population was 9.20±1.29 in 103 subjects, 10.5±1.29 in 72 subjects and 8.83±2.12 respectively [5-7].

On comparing the findings of the present study with the studies done in non-Indian population [Table/Fig-6] [8-10,12,14,15,19-

23], irrespective of different races, present observations were approximately matching with the findings of Yazdi HR and Sotoudeh H, Arjmand SA et al., Ongoiba N et al., and Adibi A and Givichian B who observed a mean portal vein diameter of  $9.6\pm 1.9$ ,  $9.16\pm 2.58$ ,  $9.36\pm 1.65$  and  $9.75\pm 1.25$  mm respectively [8,12,20,23]. It is clear that PVD varies among different populations. Therefore, regional variations should be borne in mind while diagnosing cases of portal hypertension.

In the present study male showed a significantly higher mean PVD ( $9.70\pm 1.02$  mm) as compared to females ( $9.10\pm 0.94$ ). Findings of our study resonates with that of Saha N et al., Yazdi HR et al., Gupta E et al., and Arjmand SA et al., who also supported a higher dimensions of portal vein in males [7,8,11,12]. Possibly females show lesser degree of growth in comparison to their male counterparts therefore their body organs are also of smaller size. However, few authors [9,13-15] denied any significant difference in PVD of two genders.

While reviewing literature for gender differences in PVD, it was noticed that sample size was major predictor for determining mean values; therefore, properly designed studies are required.

Present study depicted a non-linear association between age of each gender and portal vein diameter as in first two groups there was an increase in portal vein diameter with increasing age whereas in the third group it decreased [Table/Fig-4,5]. This can be attributed to less number of subjects in the third group; therefore the data of this group may be comparatively less reliable. Few authors [13,14] reported a statistically significant positive correlation between age and PVD whereas few others [9,15] though observed an increase in diameter with age but this increment was not statistically significant. However studies conducted on children by Ghosh T et al., EL Sharkawy E et al., and Lopez BAM et al., observed a statistically significant increase in PVD with age [13,24,25]. Therefore, from the present study and available literature it may be concluded that portal vein diameter increases proportionally with age from childhood till adolescent whereas increase thereafter is not significant.

## LIMITATION

In the present study however difference in the age of groups did not include extremes, therefore adequate correlation between age and PVD was beyond the scope of this study.

## CONCLUSION

Variability in results of earlier studies dealing with portal vein measurements necessitates the need for establishing local standard values. In the given subset of young adults mean PVD was ( $9.49\pm 1.03$  mm). In males mean portal vein diameter was observed to be higher ( $9.70\pm 1.02$  mm) as compared to females ( $9.10\pm 0.94$  mm). The information will be helpful in prompt diagnosis and management of portal hypertension.

## REFERENCES

- [1] Williams PL, Warwick R, Dyson M, Bannister LH. Gray's Anatomy. 37<sup>th</sup> Edn. Edinburgh: Churchill Livingstone. 1989; pp. 818-22.

- [2] Gupta TK, Chen L, Groszmann RJ. Pathophysiology of portal hypertension. *Baillieres Clin Gastroenterol.* 1997;11:203-19.
- [3] Moore KL. *Clinical Oriented Anatomy.* 5<sup>th</sup> ed. Philadelphia: Lippincott, Williams and Wilkins. 2006; Pp. 260-62.
- [4] Meire EB, Dewbury KC, Cosgrove DO. *Abdominal and General Ultrasound.* Editor: Cosgrove D, Meire H, Dewbury K. Edinburgh: Churchill Livingstone. 1993;1:311.
- [5] Khandare V, Mehta LA. Evaluation of diameter of portal vein at porta hepatis on ultrasound in adults. *Indmedica-Journal of the Anatomical Society of India.* 2005;54(1):228.
- [6] Goyal AK, Pkharma DS, Sharma SK. Ultrasonic measurements of portal vasculature in diagnosis of portal hypertension. A controversial subject reviewed. *J Ultrasound Med.* 1990;9(1):45-48.
- [7] Saha N, Sarkar R, Singh MM. Portal vein diameter in a tertiary care centre in North-East India. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS).* 2015;14(12):110-13.
- [8] Yazdi HR, Sotoudeh H. Assessment of normal doppler parameters of portal vein and hepatic artery in 37 healthy Iranian volunteers. *Iran J Radiol.* 2006;4:213-16.
- [9] Hawaz Y, Admassie D, Kebede T. Ultrasound assessment of normal portal vein diameter in Ethiopians done at Tikur Anbessa Specialized Hospital. *East Cent Afr J Surg.* 2012;17(1):90-93.
- [10] Chuo LS, Mahmud R, Salih QA. Color doppler ultrasound examination of the main portal vein and inferior vena cava in normal Malaysian adult population: A fasting and post prandial evaluation. *Internet J Cardiovascular Res.* 2005;2(2):1-6.
- [11] Gupta E, Usman N, Gupta A. Sonographic evaluation of portal vein diameter in north Indian population. *National Journal of Integrated Research in Medicine.* 2013;4(2):1-4.
- [12] Arjmand Shabestari A, Bagherzadeh Yazdi MH. Measurement of main portal vein diameter, peak velocity and volume flow and its associated factors in healthy adults. *Pajouhandeh Quarterly Research Journal.* 2003;31:25-30.
- [13] Ghosh T, Banerjee M, Basu S, Das R, Kumar P, De S, et al. Assessment of normal portal vein diameter in children. *Trop Gastroenterol.* 2014;35(2):79-84
- [14] Siddiqui TR, Hassan N, Gul P. Impact of anthropometrical parameters on portal vein diameter and liver size in a subset of Karachi based population. *Pak J Med Sci.* 2014;30(2):384-88.
- [15] Anakwue AC, Anakwue RC, Ugwu AC. Sonographic evaluation of normal portal vein diameter in Nigerians. *Euro J Sci Res.* 2009;36(1):114-17.
- [16] Shankar R, Shetty GS, Srinath MG, Kulkarni R. Estimation of portal vein diameter in correlation with the age, sex and height of an individual. *Anatomica Karnataka.* 2011;5(2):13-16.
- [17] Abdel-Latif Z, Abdel-Wahab MF, El-Kady NM. Evaluation of portal hypertension in cases of hepatosplenic schistosomiasis using ultrasound. *JCU.* 1981;9:409-12.
- [18] Michael hennerici, Doris Neuerburg-Heusle. *Vascular Diagnosis with ultrasound,* 2<sup>nd</sup> ed, Stuttgart: Thieme medical publishers. 1998; pp. 285-86.
- [19] Tasu JP, Rocher L, Peletier G, Kuoch V, Kuhl E, Miquel A, et al. Hepatic venous pressure gradients measured by duplex ultrasound. *Clin Radiol.* 2002;57:746-52.
- [20] Ongoiba N, Sissoko F, Ouologuem I, Berete S, Traore AK, Sidibe S, et al. Portal vein: echographic anatomy. *Morphologie.* 2003;87(277):29-32.
- [21] Yazdi HR, Kalilian MR. Sonographic assessment of respiratory variations in diameter of portal and splenic veins in cirrhotic patients and healthy controls. *Iran J Radiol.* 2005;2(3,4):95-98.
- [22] Sudhamshu KC, Matsutani S, Maruyama H, Akiike T, Saisho H. Doppler study of hepatic vein in cirrhotic patients: Correlation with liver dysfunction and hepatic hemodynamics. *World J Gastroenterol.* 2006;12(36):5853-58.
- [23] Adibi A, Givechian B. Diameter of common bile duct: what are the predicting factors? *Journal of Research in Medical Sciences.* 2007;12(3):121-24.
- [24] El Sharkawy E, Faris R, Grumbach K, Edelman R, Clemens J, Rao M, et al. Ultrasonographic measurements of the normal liver and spleen among Egyptians 10-50-year-old. *The Journal of the Egyptian Public Health Association.* 1996;72(3-4):257-83.
- [25] López Barrio AM, de Palma Gastón MA, Muñoz Conde J. Portal blood flow studied in children with portal hypertension using Doppler duplex echocardiography. *An Esp Pediatr.* 1996;44(2):92-96.

### PARTICULARS OF CONTRIBUTORS:

1. Senior Resident, Department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India.
2. Assistant Professor, Department of Anatomy, King George Medical College, Lucknow, Uttar Pradesh, India.
3. Professor, Department of Anatomy, King George Medical College, Lucknow, Uttar Pradesh, India.
4. Professor and Head, Department of Anatomy, King George Medical College, Lucknow, Uttar Pradesh, India.
5. Assistant Professor, Department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India.

### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Shikha Singh,  
Senior Resident, Department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India.  
E-mail: ariez\_shikha@yahoo.co.in

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jul 19, 2016**  
Date of Peer Review: **Aug 12, 2016**  
Date of Acceptance: **Nov 03, 2016**  
Date of Publishing: **Mar 01, 2017**