

Measurement of Portal Vein Diameter, Peak Systolic Velocity and Pulsatility Index by Ultrasound Doppler Evaluation in Asymptomatic Nepalese Population.

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Abstract

Introduction: Portal vein diameter and Doppler studies give hemodynamic information that can correlate with disease status. Their normal values are not established in Nepalese population. This study aims to establish the normal values of portal vein diameter, PSV and PI in Nepalese population and study their variability with age, gender and ethnicity.

Methods: Cross-sectional hospital based study. All adults more than 20 years of age attending ultrasound OPD of Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu for general health check up were included. Patients with liver disease, cardiac disease and ascites were excluded. A single observer took all measurements. Data were entered in a predesigned proforma and analysis was performed with SPSS 21.0.

Results: Two hundred patients were included in the study. The mean age was 44.34 ± 12.9 years. The mean portal vein diameter was 10.41 ± 1.18 mm. The mean portal vein PSV was 33.35 ± 9.3 cm/s and PI was 0.76 ± 0.07 . There was a positive correlation of portal vein diameter with age ($r=0.345$; $p<0.001$). Also, mean portal vein diameter was significantly higher in males (10.9 ± 0.99 mm) than in females (9.9 ± 1.1 mm). PSV and PI did not differ with age, gender or ethnicity.

Conclusions: Mean portal vein diameter in this study is comparable with previous standards.

Keywords: Peak systolic velocity, portal vein diameter, pulsatility index

Introduction

Abdominal ultrasound is a useful and commonly used imaging modality to evaluate liver pathologies and portal hypertension.¹ Doppler studies can add further hemodynamic information that can correlate with disease status, which might help in the diagnosis of portal hypertension and possibly early portal hypertension.² Portal vein diameter increases in portal hypertension before the development of portosystemic shunts but may normalize after formation of collaterals.

Thus an increase in portal vein diameter (>13 mm) has high specificity in the assessment of portal hypertension but low sensitivity.^{3,4} Portal vein peak systolic velocity (PSV) and portal vein pulsatility index (PI) are indices calculated from the spectral evaluation of portal vein to assess the hemodynamic status of portal circulation. Portal vein normal waveform shows gentle undulation with flow towards the liver i.e. hepatopetal flow. In portal hypertension, with progression of disease, as sinusoidal pressure increases, the portal venous flow reduces (slow flow) which may even stop (no flow) or flow away from

liver i.e. hepatofugal flow (reverse flow).^{1,2} However, hemodynamic changes in portal vein might also occur with physiological states like postprandial state, or with body size or ethnicity. The normal values of portal vein diameter and its Doppler indices have not been previously established in Nepalese population. Thus this study aims to establish the normal value of portal vein diameter, PSV and PI in Nepalese population and study their variation with age, gender and ethnicity.

Methods

This study was a cross-sectional study in a tertiary care teaching hospital for the duration of one year from August 2013 to July 2014. Ethical approval was obtained from the Institutional Review Board. All adults more than 20 years of age attending the ultrasound OPD for the general health check up were included. Patients with abnormal liver function test, fatty liver, splenomegaly, cardiac disease, ascites, body swelling and poor acoustic window were excluded.

A single observer measured the parameters on Samsung Medison UGEO H60 ultrasound unit using 3.2MHz curvilinear probe. Portal vein diameter was measured from inner to inner wall at the crossing of common hepatic artery.⁵ PSV and PI were measured with sample volume cursor at the centre of the portal vein lumen, midway between the splenomesenteric confluence and portal vein division into left and right hepatic branches.^{6,7} Sample volume size was taken from 2/3rd of vessel diameter. The angle between the longitudinal axis of portal vein and Doppler beam was maintained at 30-60 degrees. The mean of three consecutive spectral wave manual tracings was taken for calculation of the indices. Portal vein PSV was taken as the highest value of the sinusoidal waveform. Portal venous PI was calculated as $V2/V1$, where $V1$ is the peak portal velocity (systolic) and $V2$ is the trough velocity (end diastolic).

Data were entered in a predesigned proforma and statistical analysis was performed using SPSS 21.0. Results were expressed as mean±standard deviation for portal vein diameter, PSV and PI. Also, the correlations between age, gender and ethnicity were obtained with the diameter, PSV and PI.

Results

A total of 200 patients who met inclusion criteria were included. The mean age of the study population was 44.34 ± 12.90 years with median age at 43 years and interquartile range of 19. Most patients were of 31-40

year age group (50; 25%) followed by 41-50 year age group (48; 24%) and then by 51-60 year age group (46; 23%). (Figure 1) Among 200 participants, 106 (53%) were females and 94 (47%) were males.

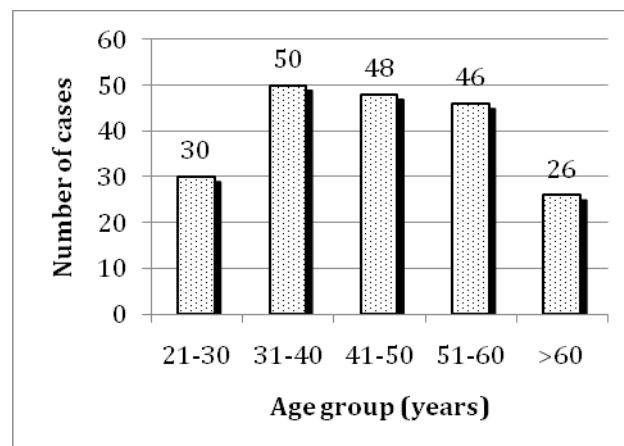


Figure 1: Age Distribution of Patients

The mean portal vein diameter was 10.41 ± 1.18 mm. The median diameter was 10.3 mm with interquartile range of 1.7 mm. Minimum portal vein diameter was 7.2 mm and the maximum was 12.5 mm. The mean PSV was 33.35 ± 9.3 cm/s with median of 34 cm/s and interquartile range of 14 cm/s. Minimum portal vein PSV was 16 cm/s and the maximum was 64 cm/s. The mean portal vein PI was 0.76 ± 0.07 . The median portal vein PI was 0.76 with interquartile range of 0.11. Minimum portal vein PI was 0.57 and the maximum was 0.91. The variation of portal vein diameter, PSV and PI are given in Table 1.

There was a positive linear correlation of portal vein diameter with age ($r = +0.345$; $p < 0.001$). (Figure 2)

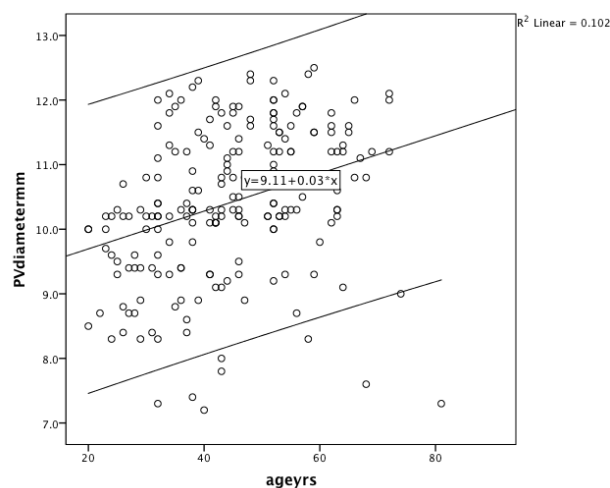


Figure 2: Scatter Diagram Showing Correlation of Portal Vein Diameter with Age

Also, portal vein diameter was significantly greater in males (10.9±0.99 mm) than in females (9.9±1.1 mm) with p<0.001.

Table 1: Variation of Portal Vein Parameters with Gender

Characteristic	Male N=94	Female N=106	P value
PV diameter (mm)	10.9±0.99	9.9±1.1	t= 6.435 df=198; p<0.001
PSV (cm/s)	34.01±9.2	32.76±9.4	t=0.943 df=198; p=0.347
PI	0.75±0.08	0.76±0.07	t=0.469 df=198; p=0.640

PV- Portal Vein, PSV- Peak Systolic Velocity; PI- Pulsatility Index

However portal vein PSV and PI did not show significant correlation with age or gender (Table 1 and 2).

Table 2. Mean Portal Vein Diameter, PSV and PI according to Age Group

Age group (years)	20-30 n=30	31-40 n=50	41-50 n=48	51-60 n=46	> 60 n=26	p-value
PV Diameter (mm)	9.54±0.74	10.16±1.29	10.56±1.08	10.9±1.01	10.71±1.25	<0.001
PSV (cm/s)	32.03±12.10	31.28±8.13	35.85±9.22	33.15±8.77	34.58±8.39	0.13
PI	0.74±0.07	0.76±0.06	0.76±0.07	0.78±0.08	0.76±0.07	0.26

PV- Portal Vein, PSV- Peak Systolic Velocity; PI- Pulsatility Index

Likewise, there was no correlation between portal vein diameter, PSV and PI with ethnicity as well (Table 3).

Table 3: Variation of Portal Vein Parameters with Ethnicity

Characteristic	B/C	J	M	D	p-value
PV diameter	10.5±1.2	10.3±1.2	10.3±0.9	10.1±1.5	0.580
PSV	33.6±10.1	32.8±8.2	34.1±9.4	34.4±9.8	0.921
PI	0.75±0.07	0.78±0.07	0.76±0.08	0.75±0.07	0.139

B/C- Brahmin/Chhetri; J- Janajati, M- Madhesi, D- Dalit. PV – Portal Vein; PSV- Peak Systolic Velocity; PI- Pulsatility Index.

Discussion

Ultrasound evaluation of portal vein including Doppler indices provides useful anatomical and physiological information about various disease processes, mainly portal hypertension.¹ Portal vein diameter, PSV and PI are three commonly measured indices.²

The mean PV diameter was 10.41±1.18mm in our study. A wide variation of mean portal vein diameter was established by previous studies ranging from 7.9 to 11.7mm. ⁷⁻¹⁰ The wide variation is possibly due to variation in the study population, geography, ethnicity and measurement techniques. Most studies measured at

the widest part distal to splenomesenteric confluence, which might vary in different patients depending on the course and tortuosity of the portal vein. Also, there could be subjective variation in selection of the widest diameter. We measured portal vein diameter at the crossing of hepatic artery and portal vein for a more consistent position. The interobserver variability for measurement of various sites of portal venous diameter has not been previously studied. A portal vein diameter of more than 13mm is considered pathological indicative of portal hypertension³. The maximum portal vein diameter in our study was 12.5mm, thus the cutoff value of 13mm to diagnose portal vein dilation is supported by our study.

The mean portal vein PSV was 33.35 ± 9.3 cm/s in our study. This finding is similar to that from previous studies. Rokni et al⁸ found the PSV to be 35.3 ± 16.5 cm/s, though the measurement was obtained at the crossing point with inferior vena cava. Portal vein PSV of less than 16 cm/s is used as cutoff to diagnose portal hypertension.² The normal range of portal vein PSV in our study was 14.75 cm/s to 51.95 cm/s.

Likewise, the mean PI in our study was 0.76 ± 0.07 . The minimum PI was 0.57. The normal range of PI in our study was 0.64 to 0.9, which is higher than the previously used cutoff of less than 0.5 to diagnose portal hypertension.²

We observed a positive correlation of portal vein diameter with age while no correlation of portal vein PSV or PI with age. Various studies have shown similar positive correlation of portal vein diameter with age^{7, 11-13} and some also have shown no correlation.⁹ Previous studies have not assessed the variation of portal vein PSV and PI with anthropological parameters.

We also observed the variation of portal vein diameter with gender, males having a larger diameter than females do. The theoretical explanation for this phenomenon is given by the larger body size of males as compared to females. However, literature varies in demonstrating the variation of gender with portal vein diameter with both in favor^{8, 13} and against it.^{7, 11, 14} Portal vein PSV and PI did not show any variation with gender.

Our study did not show any significant variation of portal vein diameter, PI and PSV with ethnicity. Previous studies have not analyzed the variation with the ethnicity.

Our study had certain limitations. The study was carried out in patients who visited the hospital for the general health checkup, thus may not be representative of the population. We did not take into account parameters like patient height, weight, BMI and liver size which possibly could result in the variation of portal vein study.

This study is the first of its type in our country. The mean portal vein diameter and its correlation with age and gender in this study are comparable with previous standards. But other larger population-based studies need to be conducted to determine the normal range

of the diameter, PSV and PI and their reliability to define portal hypertension. Also, we found that portal vein PSV and PI are more consistent variables with no variation with age, gender or ethnicity and thus may be more reliable indicator than portal vein diameter.

Conclusion

Portal vein diameter and Doppler indices providing hemodynamic information are useful parameters that can correlate with disease status. Their normal values are measured in adult Nepalese population with this study. Positive correlation of portal vein diameter is noted with age. Also portal vein diameter is noted higher in males than in females. Hence, this study tried to establish the normal values of these indices in adult Nepalese population.

Conflict of interest: None declared

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