

Ultrasound Diameter of the Portal Vein to Healthy Adult in Parakou (Benin)

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Abstract

Introduction: The portal vein (PVD) diameter is one of the predictive variables of portal hypertension. This diameter can differ according to the population. The objective of this study was to determine the PVD in a healthy adult population in Parakou using ultrasonography. **Methods:** A cross-sectional descriptive study was conducted in the medical imaging department of the Borgou and Alibori University-affiliated Hospitals in Parakou from July 1st to October 1st, 2019. The study population consisted of 201 healthy adults. The ultrasound diameter of the portal vein was measured at the level of the hepatic hilum on a cross-sectional epigastric view and on an oblique intercostal view. An association was sought between the PVD and sociodemographic and anthropometric factors. **Results:** The mean age was 28.97 ± 10.56 years and the sex ratio (M/F) was 0.79. The mean PVD in regular breathing (FB) was 9.83 ± 0.95 mm with a 95% confidence interval of [9.70; 9.97], a 95th percentile of 11.49 mm with extremes of 7.50 mm and 12.23 mm. PVD was correlated with age, sex, weight, height and abdominal girth. After multiple linear regressions ($r = 0.19$), there was correlation between the PVD in normal breathing with age ($p = 0.0090$), weight ($p = 0.0026$), body mass index ($p = 0.0171$) and body surface ($p = 0.004$). **Conclusion:** A PVD greater in normal adults is less than 12 mm and seems to be correlated to the subject age, weight, body mass index and body surface. A more than 13 mm PVD should lead to the suspicion of portal vein hypertension in adults in our populations.

Keywords

Portal Vein, Ultrasound, Portal Vein Hypertension, Parakou

1. Introduction

The portal vein (PVD) diameter and the portal vein flow are part of the monitoring parameters in patient with cirrhosis to depict portal vein hypertension (PVH). PVH is defined as an increase in pressure of the portal venous system with a systemic to portal pressure gradient greater than 5 mmHg [1] [2]. It is the most frequent complication in patients with cirrhosis [2] [3].

The reference method for the diagnosis of PVH is catheterization of the peri-hepatic veins [4], which is an invasive technique not available in our context. The clinical manifestations of PVH are late-onset. Splenomegaly is the first sign to appear but already indicates advanced PVH [2].

Imaging with Doppler ultrasound allows diagnosis based on the study of the blood flow in the portal vein before the occurrence of changes in diameter. In our context, Doppler-equipped ultrasound devices are not widely available. Thus, B-mode ultrasonography, which measures the diameter of the portal vein as an indirect reflection of the portal pressure, is the most accessible and widely used technique [5] [6].

In the various studies and depending on the country, the normal diameter of the vein and the threshold value for the diagnosis of PVH varied [7] [8].

The upper limit of normality of portal vein diameter was found to be 14.5 mm [7].

It is with a view to determining the normal diameter of the portal vein in our population that this work was initiated.

2. Methods

This was a cross-sectional, descriptive study with prospective data collection. It was conducted from July 1st to October 1st, 2019 in the Medical Imaging Department of the National University Hospital Center of Borgou and Alibori Department (DNUHC-B/A) of Parakou in Benin.

Participants of 18-year-old and more, residing in Parakou and who had given informed consent were included in the study. Subjects with diabetes mellitus, amenorrhea (pregnant or not), a history of hepatobiliary disease, clinical signs of hepatopathy (hepatomegaly, signs of portal hypertension, etc.) or cardiovascular disease (hypertension, cardiac failure, etc.) were not included. We excluded subjects who could not perform deep breathing, those in whom ultrasound revealed hepatobiliary or splenic abnormalities, those with a pregnant uterus on ultrasound and subjects in whom the portal vein could not be measured satisfactorily (obese subjects, subjects with excess gas).

An abdominopelvic ultrasound was performed by the radiologist after fasting period of at least 06 hours. The examination was performed in B mode using a Mindray ultrasound machine, model Digi Prince 8800 plus[®] equipped with two multi-frequency probes, one low-frequency convex (2.5 - 5 MHz) and the other high-frequency linear (5 - 10 MHz). The diameter of the portal vein was measured in its extrahepatic portion at the hepatic hilum where its visualization was

optimal. This measurement was performed in normal breathing (NB), in deep exhalation (DE), and in deep inspiration (DI). All measurements were taken three times by the same radiologist and averaged to improve the accuracy of the results and reduce the influence of intra-observer variability.

Other variables were weight, height, BMI, body surface and abdominal circumference. Patients' heights were measured in standing position using a height gauge with the head in Frankfurts' position after removing their shoes. Weight was measured using a weighing scale to the nearest 0.1 kg. Both measurements were used to calculate the BMI and body surface area. Abdominal circumference was measured at the level of the umbilicus using a measuring tape.

The data collected was recorded in the Epi data manager software and the analysis of these data was carried out using EPI INFO v7.2, EpiData analysis v2.2.3.187 and SPSS 22. The averages were compared by using either the Student test (Anova) or Wilcoxon test as appropriate. An association was sought between the PVD and sociodemographic factors (age, gender, ethnicity) and between the PVD and anthropometric factors (weight, height, BMI, body surface, abdominal circumference). A two-by-two bi-variate analysis followed by multiple linear regression was used. A p-value of less than 0.05 was considered significant.

This study is performed in accordance with the study protocol, the Declaration of Helsinki (October 2013) and the WHO Handbook for Good Clinical Research Practice (July 2002) as well as any other applicable national and other regulatory guidelines in Benin. The free and informed consent of all the subjects surveyed was obtained. All data collected during our survey were used only for the purposes of this study and remained confidential. We received authorisation from the CLERB-UP (Local Ethics Committee for Biomedical Research of the University of Parakou) for our study.

3. Results

3.1. Description of the Study Population

A total of 201 subjects were included. The mean age was 28.97 ± 10.56 years with a median of 25 years and extremes of 18 and 75 years. Females were the most represented (55.72%) with a sex ratio (M/F) of 0.79. The study population generally had a normal BMI (64.68%) according to the WHO IMC classification. **Table 1** shows the distribution of the study population according to anthropometric data.

3.2. Ultrasound Diameter of the Portal Vein

The mean ultrasound diameter in normal breathing of the portal vein was 9.83 ± 0.95 mm with extremes of 7.50 mm and 12.23 mm. The 95th percentile of DPV in FB was 11.49 mm. **Table 2** shows the distribution of the mean DPV as a function of respiratory maneuvers. **Figure 1** illustrates the variations in portal vein diameter as a function of respiratory maneuvers.

Table 1. Anthropometric parameters of the study population.

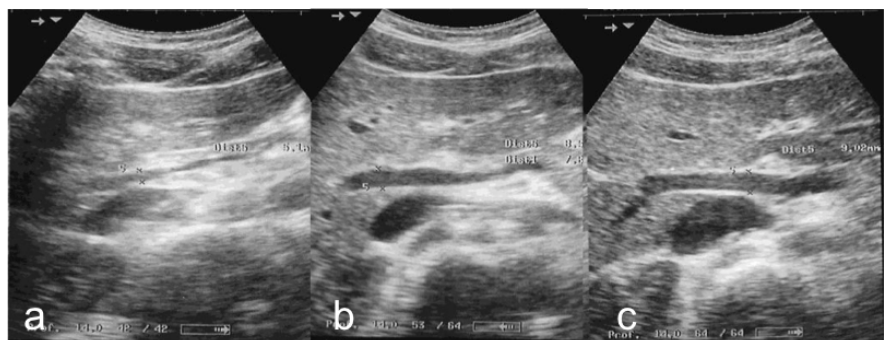
	Min	1st Q	Mean	Gap-T	Med	3rd Q	Max	IC 95%
Weight	39.00	57.00	65.18	11.72	64.00	71.00	109.00	63.55 - 66.81
Height	1.50	1.62	1.67	0.07	1.68	1.73	1.94	1.66 - 1.68
BMI	15.62	20.04	23.35	4.39	22.58	25.96	43.66	22.74 - 23.96
Abdo circumf	60.00	72.00	80.37	11.58	78.00	87.00	120.00	78.77 - 81.99
Body surface	1.30	1.62	1.73	0.16	1.72	1.82	2.18	1.71 - 1.76

Mean \pm Gap-T = Mean \pm standard deviation, 1st - 3rd Quartile, Med = Median, Min = Minimum, Max = Maximum, 95% CI: 95% Confidence Interval.

Table 2. PVD in normal breathing, DI, and DE.

	Min	1st Q	Mean	Gap-T	Med	3rd Q	Max	IC 95%
NB	7.50	9.20	9.83	0.95	9.90	10.40	12.23	9.70 - 9.97
DI	8.00	10.00	10.87	1.12	10.90	11.65	13.90	10.71 - 11.03
DE	6.30	8.10	8.72	0.93	8.70	9.40	11.00	8.59 - 8.85

Mean \pm Gap-t = Means \pm standard deviations, Medians, 1st - 3rd Quartile, Min = Minimum, Max = Maximum.

**Figure 1.** Diameter of the portal vein at different stages of respiration (a) In deep exhalation, (b) In free/normal breathing, (c) In deep inspiration.

3.3. Factors Influencing the Diameter of the Portal Vein

After simple linear regression (**Table 3**), there was no correlation between the PVD in normal breathing with body mass index. On the other hand, the PVD in normal breathing was correlated with age, gender, weight, height, abdominal girth and body surface.

After multiple linear regressions (**Table 4**), there was correlation between the PVD in normal breathing with age, weight, body mass index and body surface.

4. Discussion

The free-breathing DPV in our study ranged from 7.5 to 12.33 mm with an average of 9.83 ± 0.95 mm. These results are within the range of what is conventionally reported. **Table 5** reports the different DPV values found in other

Table 3. Factors influencing the PVD in simple linear regression.

	Beta Coefficient	Es	r	p-value
Age	0.02	0.01	0.05	0.0019
Gender	-0.46	0.13	0.06	0.0005
Abdominal girth	0.02	0.01	0.05	0.0024
Weight	0.02	0.01	0.06	0.0005
Height	0.03	0.01	0.07	0.0002
BMI	0.03	0.01	0.01	0.0838
Body surface	0.00	0.00	0.10	<0.0000

Table 4. Factors influencing the PVD in multiple linear regression.

	Beta Coefficient	Es	p-value
Age	0.02	0.01	0.0090
Weight	-0.31	0.10	0.0026
BMI	0.24	0.01	0.0171
Body Surface	0.02	0.00	0.0004

Coefficient of correlation $r = 0.19$.

Table 5. DPV value according to other authors.

	Year	Country	PVD* (mm)
Bellamy <i>et al.</i> [17]	1984	England	7.2 ± 2.3
Hawaz <i>et al.</i> [19]	2012	Ethiopia	7.9 ± 2
Saha <i>et al.</i> [23]	2015	India	8.83 ± 2.12
Rahim <i>et al.</i> [11]	1985	England	8.76 ± 1.5
Rokni <i>et al.</i> [13]	2005	Iran	8.9 ± 1.08
Rokni <i>et al.</i> [14]	2006	Iran	9.36 ± 1.65
Luntsi <i>et al.</i> [18]	2016	Nigeria	9.60 ± 1.41
Mildenberger <i>et al.</i> [12]	1987	Germany	9.7 ± 1.7
Our study	2019	Benin	9.83 ± 0.95
Lal <i>et al.</i> [7]	2018	India	10.2 ± 1.47
Adeyekun <i>et al.</i> [20]	2014	Nigeria	10.3 ± 1.5
Geleto <i>et al.</i> [8]	2016	Ethiopia	10.6 ± 1.8
Wiersema <i>et al.</i> [16]	1995	United States	10.7 ± 1.7
Gareeballah <i>et al.</i> [22]	2017	Sudan	10.73 ± 1.47
Usman <i>et al.</i> [9]	2015	Nigeria	10.87 ± 0.81
Weinreb <i>et al.</i> [10]	1982	United States	11.00 ± 2
Anakwue <i>et al.</i> [21]	2009	Nigeria	11.45 ± 1.49
Cosar <i>et al.</i> [15]	2004	Turkey	11.68 ± 0.26

*mean ± Gap-T.

studies. The variations between the different studies could be explained not only by racial variations but also by the measurement technique used, different maneuvers performed to better visualize the portal vein and the cooperation of the subject who performs them [7] [9]-[23].

Socio-demographic and anthropometric characteristics are variably correlated with PVD in the different studies. In our study, the factors associated with PVD after simple linear regression were: age, gender, weight, height, abdominal girth and body surface.

Adeyekun *et al.* [20] in Nigeria in 2014, Weinreb *et al.* [10] in the United States in 1982, Cosar *et al.* [15] in Turkey in 2004 found no factors associated with PVD. Usman *et al.* [9] and Geleto *et al.* [8] found only age and sex as associated factors in their studies in Nigeria in 2015 and Ethiopia in 2016 respectively. Weight and height were associated factors in Gareeballah *et al.* [22] in Sudan in 2017, Saha *et al.* [23] in India in 2015.

As in our study, Lal *et al.* [7] in India in 2018, after a bivariate analysis found sex, weight, height and abdominal girth as associated factors. After multiple linear regression, they found height as the only factor weakly associated with PVD.

The interest of measuring the average DPV is to be able to determine the threshold at which portal hypertension can be suspected. This threshold in case of chronic hepatopathy varies between 12 and 15 mm according to different recommendations [8] [24]. Among the various recommendations concerning the PVD threshold value for the diagnosis of PVH, the one that comes closest to our results comes from SIAD (abdominal and digestive imaging society). According to its recommendations, PVH should be suspected in a patient with chronic liver disease when the PVD measured outside the hepatic parenchyma is greater than 12 mm [1].

In the present study, 95% of the population (95th percentile) had a PVD less than or equal to 11.49 mm and the maximum value found was 12.33 mm. Pending further studies necessary to determine the precise threshold value for the diagnosis of PVH, Parakou should suspect PVH when the PVD is greater than 13 mm in cases of chronic liver disease.

The main limitation of this study is the lack of biological assessments. This did not allow us to verify the normality of the liver tests in the participants and thus formally rule out a hepatopathy.

5. Conclusion

The adult PVD diameter in Parakou is on average 9.83 ± 0.95 mm with a 95th percentile of 11.49 mm. Pending further studies, a PVD greater than 13 mm should lead to the suspicion of PVH in adults in our populations. It has shown an association between age, weight, BMI and body surface with PVD.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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