Sonographic assessment of the portal vein diameter in apparently healthy adults in a Northern Nigerian population.

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Abstract

Background: Sonography is a valuable tool in the assessment of porto-systemic pathologies. This study aimed at determining the mean portal vein diameter based on age, gender and anthropometric variables.

Methods: A cross sectional study conducted among 201 apparently healthy adults in Bauchi Metropolis. Participants were recruited from the school of nursing AbubakarTafawa Balewa Teaching Hospital (ATBUTH), Bauchi. Ultrasound machine ALOKA SSD-1000, (IP-1233EV, SN-57324, Japan) with curvilinear transducer with frequency of 3-5MHz was used for a period of four months, (December 2015 to April 2016). Participants' heights were measured while standing against a meter rule with the head in Frankfurts' position and weight measured using a weighing scale. Data analysis was done using SPSS version 22.0. Descriptive statistics (mean, standard deviation), and Pearson's Correlation were used.

Results: The mean portal vein diameter was 9.60 ± 1.41mm for both sexes. The mean value for males was 9.71 ± 1.42mm, and 9.35±1.46mm among females. There was a positive correlation correlation between the PV diameter and Body Mass Index ($P \leq 0.01$).

Conclusion: This study found the mean values of PV diameter in apparently healthy adults in our environment to be 9.60 ± 1.41mm and that PV diameter positively correlates with anthropometric variables.

Keywords: Portal vein diameter, sonography, Nigerian population, healthy adults.

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Introduction

The portal vein (PV) and hepatic artery forms the liver's dual blood supply. Majority (about 75%) of hepatic blood flow is derived from portal vein while the remainder comes from the hepatic artery. The portal vein (PV) is formed by the confluence of superior mesenteric vein and splenic vein, behind the neck of the pancreas at the level of second lumbar vertebra[1]. Sonographic measurement of the portal vein diameter is a corner stone and also has a reasonable accuracy in diagnosing patients suspected of having portal hypertension[2]. The intricate relationship between the liver and the portal vein maintains homeostasis in the human body[1].

The major abnormality of the portal venous system is portal hypertension which may occur due to increased resistance to portal blood flow due to alterations in the liver architecture that leads to enlargement of extrahepatic and intrahepatic portal vessels and the development of portosystemic collaterals[3].The formation of portosystemic-collaterals may leads to splenomegaly, ascites, encephalopathy among others[4]. Diagnostic imaging methods like portal venography, splenoportography, and arteriography have been used to evaluate patients suspected of having portal thrombosis which are invasive, expensive, time consuming and involve risk and discomfort to the patient, while computed tomography and magnetic resonance imaging have advantages of better cross sectional images but are both expensive and the former exposes patient to high doses of ionizing radiation[5,7].

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Sonography, in addition to its use of non-ionizing radiation, its accessibility, non-invasive nature, portability, low cost and ability of rapid accomplishment, makes it a good diagnostic tool which plays a great role in the diagnosis and follow up of patients with portal hypertension[2]. These examinations are often challenging and sonographers must be confident in their use and manipulation of equipment, and have thorough knowledge and understanding of the anatomy and pathophysiology of the disease process.

This study therefore intends to determine the mean values of portal vein diameter in apparently healthy Northern Nigerian adults.

Materials and methods

This was a cross-sectional prospective study carried out among apparently healthy adult subjects in Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH) Bauchi, for a period of four months from December, 2015 to April, 2016. Ethical clearance was obtained from the ethical committee and the head of Radiology department in Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, and informed consent was obtained from all the participants, prior to the study. Participants were recruited (Voluntarily) from the school of Nursing ATBUTH, Bauchi and other staff of the hospital who gave their consent.

Inclusion and exclusion criteria: Apparently healthy individuals with normal ultrasound findings of the liver formed the inclusion criteria while ill individuals, pregnant women, subjects on hepatotoxic drugs such as anti-tuberculous and antiretroviral drugs were excluded from the study.

Equipment used

An ultrasound machine ALOKA SSD-1000, (IP-1233EV, SN-57324, Japan) with curvilinear transducer with a frequency of 3.5MHz was used. Quality control maintenance check was routinely performed on the equipment by the medical physicist of the department prior to measurements. Measurements were carried out using the electronic calipers of the ultrasound machine after freezing the image.

Anthropometric parameters, like height, weight and body mass index of each participants were measured, Participants' heights were measured while standing against a meter rule with the head in Frankfurts' position after removing their shoes and their weight was measured using a weighing scale ZT WHO Scale to the nearest 0.1kg.

Scanning technique

The Ultrasound examination was carried out with the subjects in the supine and right anterior oblique position following an overnight fast. Subjects were exposed from the xiphisternum to the pelvic brim, ultrasound gel was applied to the right upper quadrants of the abdomen, and the transducer placed in the epigastrium in both the transverse and longitudinal planes to assess the main portal vein during quiet respiration, when the visualization of the portal vein was optimal, measurements were made at a point where the portal vein crosses anterior to the inferior vena cava (IVC) (fig. 1), with the calipers placed between the inner margins of the echogenic walls of the vessel. Measurements (in mm) were made twice by each of the two sonographers and the average values of the two measurements were recorded as the final value. Demographic data such as age, sex, weight, and height were recorded and the body mass index (BMI) was calculated using Quetelets' formula: BMI= weight (Kg)/height (m^2)[6].

Data analysis

Data capture sheet was used to record all the measurements obtained. Data analysis was done using Statistical Package for Social Science (SPSS) version 22.0 (SPSS Chicago, Illinois, USA). Descriptive statistics (mean, standard deviation, frequency, and percentages) and Pearson product moment correlation were used for the analysis. Statistical significance was considered at $P<0.05$.

Results

A total of 201 apparently healthy adults were enrolled for the study. The study constitutes 72 (35.82%) males and 129 (64.18%) females. The subjects were between the ages of 18-80 years, with mean age of 32.5±11.3 years. Participants within the age group of 25-29 years had the highest frequency of 15(7.46%), while those within the age group of 45-49 years had the lowest frequency of 3 (1.49%), as shown in table 1.

Table 1: Frequency distribution base on age and sex of subjects.

Age (YRS)	Male N	(%)	Female N	(%)	Total N	(%)
<20	5	2.49%	14	6.97%	19	9.45%
21 – 24	6	2.99%	19	9.45%	25	12.44%
25 – 29	15	7.46%	34	16.92%	49	24.38%
30 – 34	14	6.97%	24	11.94%	38	18.91%
35 – 39	12	5.97%	14	6.97%	26	12.94%
40 – 44	5	2.49%	12	5.97%	17	8.46%
45 – 49	3	1.49%	5	2.49%	8	3.98%
50+	12	5.97%	7	3.48%	19	9.45%
32.5±11.3	72	35.82%	129	64.18%	201	100%

Participants within the age group of 45-49 years had the highest value of 10.50 ± 1.60mm and those within the age group 25-29 years had the least value of 9.12 ± 1.52mm as shown in table 2.

Table 2: Distribution of mean PV diameter in relation to age.

	Age (Years)	Average PV DIAMETER (PVD) (Mean ±STD) mm
	<20	9.42 ± 1.30
	21 – 24	9.12 ± 1.54
	25 – 29	9.12 ± 1.52
	30 – 34	9.95 ± 1.31
	35 – 39	9.69 ± 1.32
	40 – 44	9.24 ± 1.56
	45 – 49	10.50 ± 1.60
	50+	9.47 ± 1.26
Mean ± SD	32.5±11.3	9.60 ± 1.41

The mean values of portal vein diameter in males and females were 9.71 ± 1.42mm and 9.53 ± 1.46 respectively, as shown in table 3

Table 3: Mean PV diameter in relation to gender.

	Age (YRS)	Male (MEAN±STD) mm	Female PVD (MEAN±STD) mm
	<20	10.40 ± 1.14	9.07±1.21
	21 – 24	8.83 ± 0.98	9.21±1.69
	25 – 29	9.60 ± 1.18	8.91±1.62
	30 – 34	10.21 ± 1.67	9.79 ±1.06
	35 – 39	9.58 ± 1.56	9.79±1.12
	40 – 44	9.40 ±1.34	9.17 ±1.70
	45 – 49	10.33 ± 2.08	10.60±1.52
	50+	9.50 ± 1.38	9.43 ±1.13
(Mean ± SD)	32.5±11.3	9.71 ± 1.42	9.35 ± 1.46

This study found the mean weight of 66.32 ± 10.65kg and the mean height of 1.66 ± 0.08m respectively with mean portal vein diameter of 9.60 ± 1.14mm. It also shows participants within the age group 45-49 years had the highest mean weight and height of 82.63 ± 18.26kg and 1.69 ± 0.08m respectively with mean portal vein diameter of 10.50 ± 1.60mm while the age group <20 years had the least mean weight and height of 55.21 ± 11.55kg and 1.63 ± 0.08 mm respectively with mean portal vein diameter of 9.42 ± 1.30mm. There was a positive correlation between the average portal vein diameter and weight, height for both sexes with correlation coefficients

of 0.857 and P ≤ 0.005 and 0.794 and P ≤ 0.001 respectively as shown in table 4.

Table 4: Participants weight, height and mean Portal Vein Diameter according to age group.

	Age (YEARS)	Weight (MEAN±STD)kg	Height (MEAN±STD)m	Mean PVD (MEAN±STD) mm
	<20	55.21±11.55	1.63±0.08	9.42 ± 1.30
	21 – 24	58.44±13.79	1.65±0.10	9.12 ± 1.54
	25 – 29	61.49±13.74	1.64±0.11	9.12 ± 1.52
	30 – 34	69.61±15.27	1.65±0.11	9.95 ± 1.31
	35 – 39	74.19±16.79	1.66±0.08	9.69 ± 1.32
	40 – 44	64.82±10.99	1.63±0.09	9.24 ± 1.56
	45 – 49	82.63±18.26	1.69±0.08	10.50 ± 1.60
	50+	67.32±10.65	1.66±0.10	9.47 ± 1.26
Total	32.5±11.3	66.32 ± 10.65	1.66±0.08	9.60±1.41

The mean portal vein diameter for both male and female participants with normal Body Mass Index was 9.77 ±1.41mm and 8.76 ± 1.37mm respectively. There was a positive correlation between the PV diameter and BMI of the participants (P ≤ 0.010) as shown in table 5 and figure 2.

Table 5: Participants BMI and Average Portal Vein Diameter.

BMI (kg/m^2)	Male N (%) PVD	Female N (%) PVD	P-value
Underweight (<18.50)	8(3.98) 9.77 ± 1.41	21(10.25) 8.76 ± .37	0.047
Normal (18.50-24.50)	49(24.38) 9.95 ± 1.41	45(22.39) 9.04 ± 1.43	0.043
Overweight (>25.0)	15(7.46) 9.13±1.25	63(31.34) 9.76 ± 1.39	0.053

***BMI classification was adapted from Pyrex Journal of Nursing and Midwifery[6].**

Discussion

Ultrasound imaging plays an important role in the assessment of the portal vein diameter, flow rate, and peak systolic velocity which gives an accurate and a reliable method of diagnosing disease conditions of the liver such as chronic liver diseases[2,7].

The mean portal diameter in this study was 9.60 ± 1.41mm. Similar findings were reported by other studies in Nigeria; Usman et al[7], found 10.87±0.81mm in North-Eastern Nigeria, Ukperi[8] and Adeyekun et al[5] in south western Nigeria found 8.1±0.12mm and 10.3±1.5mm respectively. Anakwue et al[9] in South Eastern Nigeria found 11.5±1.5mm as the mean portal vein diameter. This similarity in the reported portal vein diameter could be due to the similarities in the methods adopted by these studies as the measurements were all done using the trans-abdominal approach and using similar probe frequencies.

However, studies conducted in other countries also report similar findings. Ongoiba et al10 in Bamako, Mali reported a mean value of 9.2±2.6mm. Hawaz et al[2] among Ethiopians reported a mean value of 10.0±1.8mm, Webb et al[11] reported mean portal vein diameter of 6.3±2.3mm, Weinerb et al[12] in USA reported a mean value of 11±2.0mm, Rokni-Yazdi et al[13] in Iran, reported a mean value of 9.36±1.65mm, Bhattacharya et al[1] in West Bengal, India reported a mean value of 10.02±0.89mm. The reported values of the PV diameter from studies from other countries and among different ethnic groups and races, with varying samples sizes, did not vary with the values obtained from our study. This implies that using similar methodology and equipment in the hands of a qualified sonographer and /or sonologist, the measurement of the portal vein diameter can be reproducible and reliable.

However, one of the limitations of this present study is that only the diameter of the portal vein was measured and not the portal flow which was also assessed by Rokni-Yazdi et al[13]

Some literature haSdocumented portal vein diameter to vary with age, gender, and Body Mass Index. The mean portal vein diameter among males in this study was higher than females, being 9.71±1.42mm and 9.35±1.46mm respectively. The difference is not statistically significant ($p<0.05$). This is in agreement with the reports of Hawaz et al[2], Gosh et al[3], Adeyekun et al[5], Siddiqui et al[14], Saha et al[15] and Goyal et al[16] who found no significant influence of gender on portal vein diameter. This similarity may be attributed to larger number of females participants involved in the studies. Moreover, the influence of age on portal vein diameter has been documented by various researchers with varied results. This study showed positive correlation of age with portal vein diameter ($p<0.01$). This is in line with the study of Bhattacharya et al[1],Hawaz et al[2], Gosh et al[3], Anakwue et al[9], Weinreb et al[12], Saha et al[15] and Patriquin et al[17]. It however contradicts the findings of Adeyekun et al[5] who reported there was no statistically significant influence of age on portal vein diameter. This variation in the portal vein diameter may be attributed to difference in the phase of respiration at the time of ultrasonographic measurements.

This study also showed a positive correlation between Body Mass Index (BMI) and portal vein diameter ($p<0.01$). This is in agreement with the reports of Saha et al[15] andGosh et al[3].However, it was in contrast to the findings of Adeyekun et al[5] who reported that there was no statically significant influence of BMI on portal vein diameter. The difference in the reported value may be attributed to the sedentary life style in the Western part of Nigeria compared to the nomads in northern Nigeria who are either farming, grazing or leaving an active life. Rajashree et al[18] also reported a positive correlation between the portal vein diameter and other anthropometric parameters. The knowledge of these normal variations is essential for surgeons, sonologist and sonographers during diagnosis of problems that may relate to the portal system.

Conclusion

This study has established baseline values for normal range of portal vein diameter in apparently healthy adults in a Northern Nigerian population to be 9.60 ± 1.41mm and also found that PV diameter positively correlates with anthropometric variables.

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Authors' contribution

GL: Participated in conceptualization and design of the work, data acquisition, analysis, manuscript drafting, revision for its intellectual content and approval of the final work.

MS: Participated in conceptualization and design of the work, data acquisition, analysis, manuscript drafting, revision for its intellectual content and approval of the final work.

DZJ: Participated in data acquisition, manuscript drafting, revision for its intellectual content and approval of the final work.

NCI: Participated in conceptualization and design of the work, revision for its intellectual content and approval of the final work.

SHG: Participated in conceptualization and design of the work, revision for its intellectual content and approval of the final work.

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