H. Rokni Yazdi MD[1]
H. Sotoudeh MD[2]

Assessment of Normal Doppler Parameters of Portal Vein and Hepatic Artery in 37 Healthy Iranian Volunteers

Background/Objective: Doppler sonography is a valuable noninvasive method for the diagnosis of various liver diseases. However, there is scarce information on normal parameters of hepatic artery (HA) and portal vein (PV) in Iran. This study was conducted to assess normal Doppler indices of HA and PV in normal Iranian population.

Patients and Methods: In this cross-sectional study, 37 (18 female, 19 male) healthy volunteers aged 20-40 years underwent Doppler sonography after 8 hours of fasting. PV was assessed at crossing point with inferior vena cava in normal respiration and HA in the hepatic hilum.

Results: The mean±SD PV diameter was 9.36±1.65 mm. The mean±SD maximum, and mean velocity of PV were 35.28±16.54 and 27.317±13.139, respectively. The mean±SD peak systolic velocity and resistance index of HA were 67.64±33.48 and 0.76±0.07, respectively.

Conclusion: Normal Doppler parameters of HA and PV depend on different factors like gender, respiratory phase and technique of measurement and there is no uniform standard technique for these measurements. These factors must be considered when using Doppler parameters for diagnosis of liver disease.

Keywords: ultrasonography, Doppler, hepatic artery, portal vein, hypertension, portal

Introduction

Doppler ultrasound of liver is one of the most important noninvasive modalities in the diagnosis of liver disease. However, diagnosis of liver disorders requires normal Doppler parameters of portal vein (PV) and hepatic artery (HA).

With duplex Doppler sonography, it is possible to detect a decrease in the portal flow velocity and an increase in PV diameter — the two characteristic features of portal hypertension. More recently, increased Doppler impedance and acceleration indices have been described in the hepatic and splenic arteries in portal hypertension. Piscaglia, et al., noted that splenic artery resistant index (RI) and the portal hypertension index [(hepatic artery RI×0.69) × (splenic artery RI×0.89)], have the highest accuracy in the diagnosis of portal hypertension.[1, 2]

Rokni et al. noted 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.[3]

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

1. Assistant Professor, Department of Radiology, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran.
2. Department of Radiology, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Hadi Rokni Yazdi
Address: Department of Radiology, Imam Khomeini Hospital, Tehran, Iran.
Tel: 0098-2199192511
Fax: 0098-2166945117
E-mail: rokniyaz@sina.tums.ac.ir

Received March 16, 2006;
Accepted after revision July 2, 2006.

Summer 2006; 4: 213-216

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.[4]

Diameter and PSV of PV and HA RI, in these studies, were not similar between the healthy control groups. No similarity was also noted in site and respiratory phase of PV and HA measurements (Table 1).

In the study of Arjmand Shabestari et al. (2001), they evaluated associations of diameter, velocity, and flow of PV with height, weight, sex, body surface area and body mass index in 43 healthy Iranian adults and found that the diameters of the main PV and its branches were significantly differed among males and females.[5] To the best of our knowledge, this is the only study reporting the normal Doppler parameters of PV in Iran and we could not find similar studies for normal Doppler parameters for HA in Iranian adults.

In this study, we decided to evaluate the normal PV and HA Doppler parameters in Iranian adults.

Patients and Methods

This study was conducted from 16 October to 14 November 2004 and from 6 October to 3 November 2005, in two consequent Ramadan months-the Moslem ritual fasting month-in Imam Khomeini Hospital, Tehran. Finding fasting volunteers is easier in this month and there is no need for volunteers to tolerate fasting for a voluntary study. But probability of long-term (one or more weeks) fasting affecting hemodynamics must be considered as one of probable limitations of our study and it can be evaluated in future studies.

We studied 37 healthy 20-40 years old volunteers without any known disease and normal blood profile including complete blood count (CBC), aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and bilirubin (BIL), to rule out any asymptomatic liver disease. All participants had eight hours of fasting, assessed in supine position in quiet respiration and underwent gray scale and color Doppler sonography (HITACHI, EUB 525 Tokyo, Japan) using a 3.5 MHz convex transducer, the sample volume size was 2/3 of vessel diameter. The angle between the longitudinal axis of the liver vessels and the Doppler beam was 30-60 degrees. A board-certified radiologist with six years of experience in a gastrointestinal referal center performed all the sonographies. Doppler measurements were calculated as an average of two uniform appearing waveforms. Mean values were calculated to produce a more reliable parameter.

The diameter and the maximum and mean velocities of main PV were measured at the crossing point with the inferior vena cava (IVC), as Zwiebel noted.[6] For measurement of PV diameter, the central portion of the cursors was fixed at the echogenic outer wall of the vein. HA resistance index pulsatility index (PI), peak systolic velocity (PSV) and end-diastolic velocity (EDV) were measured at the hepatic hilum.

Exclusion criteria were pregnancy, known liver, cardiac, gastrointestinal, or hematologic diseases, poor sonographic window, organomegaly or ascites in sonography.

All data were analyzed with SPSS 11 software. Student's t-test was used for means of continuous and

Table 1. Normal portal vein (PV.) and hepatic artery (HA) parameters in different studies.

Study	Number of cases	age	Sex	PV. Diameter (mm)	PV. Maximum velocity(cm/s)	HA.RI	HA.PSV (cm/s)
Shabestari et al.	43	adult	M&F	9.6±1.9*	17.6±3.6*	-	-
Rokni et al.	36	22-75	M&F	8.9±1.1*	-	-	-
Rokni et al.	37	20-40	M&F	9.4±1.7*	35.3±16.5*	0.8±0.1▫	67.6±33.5▫
Cosar et al.	30	24-63	M	11.7±0.3•	15.9±0.9•	0.8±0.01◦	60.5±2.8◦
Tasu et al.	30	41-75	M&F	11.0±0.3▪	36.0*±4.7▪	0.7±0.2▪	-

Note: Portal vein (PV), hepatic artery (HA), resistance index (RI), peak systolic velocity (PSV)
*Measured in quit respiration and in crossing point with IVC▫ Measured in hepatic hillum • Measured in deep inspiration in widest A.P. diameter.
◦Measured in crossing point with portal vein
▪measured in middle of portal vein trunk in suspended respiration.
*In original study portal vein velocity was estimated by multiplying the maximal velocity by a correction factor of 0.57, for parabolic flow. We omitted this factor for better similarity between studies.

Chi-square test for comparing categorical variables.

This study was approved by the Ethics Committee of Tehran University of Medical Science.

Results

The mean±SD age of 37 (18 male, 19 female) healthy volunteers was 30±10 years. Normal PV and HR values are summarized in Table 2. The mean PV diameter, PV maximum and mean velocities, and HA EDV are significantly different between males and females (Table 2). No statistically significant difference was observed in HA PSV and HA RI between males and females (Table 2).

Discussion

The present study was designed to assess normal sonography and Doppler parameters of PV and HA in Iranian adults. The results of normal Doppler parameters of PV and HA taken from other studies are summarized in Table 1.

In our study, we found mean±SD PV diameter of 9.4±1.7 mm. However, we measured PV diameter at the crossing point with IVC and in normal respiration that may explain in part the variance between our results and those of other reports.

Tasu et al. studied on 50 cirrhotic and 30 healthy control individuals, and found a mean±SD PV diameter of 11.0±0.26 mm in the control group. He measured the PV diameter in the middle of PV trunk and during suspended respiration (Table 1). Another source of variance in the results found may be due to technical differences. Cosar et al. studied on 30 asymptomatic alcoholic patients and 30 healthy control individuals. They found a mean±SD PV diameter of 11.7±0.3 mm in the control group, which is not different from the measurements of Tasu et al. mentioned earlier. Cosar et al. measured the PV in deep inspiration and in the widest antero-posterior diameter. All of their participants in the control group were male (Table 1) that may be another source of discrepancy between our findings and theirs.

In our previous study on 36 cirrhotic and 36 healthy control individuals, for assessment of the effect of respiration on diameter of PV and splenic vein that performed with the same operator and technique[3], and in the study of Arjmand Shabestari, et al[5], the mean PV diameter was almost similar to what we found in the current study (Table 1).

We measured a "maximum PV velocity±SD" of 35.3±16.5 cm/s and a mean±SD "mean PV velocity" of 27.3±13.1 cm/s. Our results were relatively similar to the findings of Tasu, et al. However, they were different from the findings of Cosar et al. that may be due to differences in techniques used and the sample studied (Table 1). We also noted significant difference in maximum PV velocity with that reported by Shabestari et al., which may be due to difference in the age of participants.

We recorded a peak systolic velocity in HA of 67.6±33.5 cm/s that was not statistically significant between males and females. Our result was almost similar to the observations made by Cosar et al. though we had a much higher variations (Table 1).

The mean±SD HA resistance index was 0.8±0.1 in our study that was similar to that reported by Cosar, et al. It was however, more than that recorded by Tasu et al. that may be due to the techniques used, ethnicity of participants, etc.

In conclusion, we showed that normal Doppler parameters depend on different factors like gender, res-

Table 2. Mean (95% CI) of measured parameters in 37 male and female healthy participants.

Parameter	Male (n= 18)	Female (n = 19)	Total (n =37)	P value
PV diameter (mm)*	10.5 (9.8–11.2)	8.3 (7.7–8.9)	9.4 (8.8–9.9)	0.0001
PV maximum*velocity (cm/s)	29.5 (20.2-38.8)	40.7(34.2-47.3)	35.3(29.6-41)	0.042
PV mean velocity*(cm/s)	21.8(15.7-27.9)	32.5(26.3-38.6)	27.3(22.8-31.8)	0.014
HA PSV (cm/s)*	65.0(45.5-84.5)	70.1(55.4-84.8)	67.6(56.1-79.1)	0.659
HA EDV (cm/s)*	13.8(10.4-17)	19.9(15.4-24.4)	16.9(14-19.8)	0.029
HA RI*	0.77(0.74-0.80)	0.75(0.71-0.79)	0.76(0.74-0.79)	0.310

Note:*measured in crossing point of portal vein and IVC and in quit inspiration, * Measured in hepatic hilum.
P. value less than 0.05 is meaningful.

piratory phase and the measurement technique. So far, no uniform standard technique has been established for these measurements. Therefore, one should be aware of these differences in interpreting the results of Doppler parameters for the diagnosis of liver disease. Although, we tried to present the normal Doppler parameter values for our area further large-scale studies should be conducted to establish a standard nation-wide reference.

References

1. 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 Med & Biol 2001; 27(7): 893-899
2. Tasu JP, Rocher L, Peletier G, Kuoch V, Kulh E, Miquel A et al. Hepatic venous pressure gradients measured by duplex ultrasound. Clin Radiol 2002; 57: 746-752
3. Rokni H, Khalilian MR. Sonographic assessment of respiratory variations in diameter of portal and splenic veins in cirrhotic patients and healthy controls. Iran J Radiol 2005; 2: 95-98
4. Cosar S, Oktar SO, Cosar B, Yucel C, Ozdemir H. Doppler and gray-scale ultrasound evaluation of morphological and hemodynamic changes in liver vasculature in alcoholic patients. Eur J Radiol 2005; 54: 393-399
5. Arjmand Shabestari A, Bagherzadeh Yazdi MH.Measurment 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
6. Zwiebel WJ. Vascular disorders of the liver in: Zwiebel WJ. Introduction to vascular ultrasonography. 4th ed. Philadelphia: W.B Saunders; 2000: 431-443