Original Article

 Pak Armed Forces Med J 2011; 61 (4): 574-8

A STUDY OF DOPPLER WAVEFORM PATTERN OF HEPATIC VEINS IN PATIENTS OF ACUTE VIRAL HEPATITIS IN COMPARISON WITH CONTROL POPULATION

Saeed Ahmed Siddiqui*, Muhammad Zeeshan Ali, Tariq Mahmud Mirza, Ali Zia Asghar

Combined Military hospital Rawalpindi, *75 Med Bn Quetta Cantt

ABSTRACT

Objective: The objective of this study was to evaluate hepatic vein flow patterns in adults with acute viral hepatitis and to compare the findings with a control group of healthy people using Doppler ultrasound.

Study Design: Cross-sectional comparative study

Settings: Radiology Department Military Hospital and Combined Military Hospital Rawalpindi from 15 May 2007 to 15 November 2007.

Material and methods: Eighty patients who underwent doppler ultrasound at Military Hospital and Combined Military Hospital Rawalpindi during the study period were divided into two groups of 40 each. Cases were selected from the Out Patient Departments of Military Hospital and Combined Military Hospital Rawalpindi. Group I comprised patients with diagnosis of acute viral hepatitis based on clinical and laboratory findings. Group II included the control group comprising 40 healthy volunteers. Doppler ultrasound of hepatic veins was carried out in both the groups of patients.

Results: Abnormal wave pattern of hepatic veins on Doppler ultrasound was noted in 35 (87.5%) in group I and in 1(0.25%) of group II. One patient having abnormal Doppler wave pattern in group II subsequently developed acute viral hepatitis. Doppler ultrasound assessment of wave pattern in hepatic veins is an accurate method to differentiate a diseased liver from a normal one.

Conclusion: Doppler ultrasound of hepatic veins is a good technique to study disease status of liver.

Keywords: Acute viral hepatitis, blood flow pattern, Doppler ultrasound, hepatic vein.

INTRODUCTION

The Doppler waveform of the hepatic vein in healthy subjects is normally triphasic (two negative waves and one positive wave) because of central venous pressure variations during the cardiac cycle. It has been established that the normal triphasic hepatic vein waveform is transformed into a biphasic or monophasic waveform in patients with acute viral hepatitis and cirrhosis. Moreover, a monophasic waveform has been shown to correlate with a high Child-Pugh score and a poor survival rate[1].

Hepatic parenchymal disease such as acute viral hepatitis or liver transplant rejection has been associated with loss of this triphasic hepatic venous flow[2]. Influences of cardiac function, intraabdominal pressure, and intrathoracic pressure on hepatic vein flow pattern have also been reported. They affect not only the velocity of hepatic vein flow, but also the pulsatility[3]. Pulmonary venous hypertension and increased pressure in the right heart chambers will increase hepatic vein pulsatility, whereas increased thoracic pressure (Valsalva's maneuver) will slow down the venous return to the right heart and diminish the pulsatility of the hepatic veins[4-6].

Correspondence: Major Saeed Ahmed Siddiqui, Medical Officer, 75 Medical Battalion, Quetta
Email: alizia1527@yahoo.com
Received: 17 Aug 2010; Accepted: 07 Jan 2011

PATIENTS AND METHODS

This "cross-sectional comparative study" was conducted at Radiology Department, Military Hospital Rawalpindi / Combined Military Hospital Rawalpindi from 15 May 2007 to 15 November 2007. A total number of 80 individuals were included and divided into two groups. Group I comprised 40 patients of acute viral hepatitis diagnosed on the basis of clinical and laboratory findings and group II comprised 40 healthy individuals which served as the control. All the individuals were selected on non probability convenience sampling technique. Following criteria were used,

Inclusion Criteria:

Cases (Group I)

a. Patients in their 2nd to 6th decade of life.
b. Patients with diagnosed acute viral hepatitis based on clinical and laboratory findings.
c. Patients of both genders.

Controls (Group II)

All those individuals in second to sixth decade of life, not suffering from acute viral hepatitis or any other major illness consenting to be included in the study.

Exclusion Criteria:

a. Patients with any major thoracic or abdominal surgery.
b. Known cases of any chronic liver or heart disease.
c. Patients not willing for Doppler ultrasonography.

After seeking permission from concerned authorities and 'Hospital Ethics Committee' study was commenced. All individuals were included in the study after informed consent and underwent Doppler ultrasound at Military Hospital / Combined Military Hospital Rawalpindi. The patients were subjected to Doppler ultrasound of hepatic veins. All the patients had Doppler ultrasound by the same consultant radiologist using Aloka Prosound SSD-5500 with 3.5 - 5 MHz transducer.

Ultrasound Technique

All the individuals were examined while lying supine on the examination couch. Liver was scanned in right upper quadrant of the abdomen both subcostally and through the intercostal spaces. The transducer was oriented horizontally or slightly oblique. The insonation angle was between 40 and 60 degrees. All measurements were performed preferably in inspiration.

Ultrasound diagnostic criteria

Wave forms formed on Doppler were entered as monophasic, biphasic or triphasic, with monophasic or biphasic taken as abnormal.

The patients diagnosed as having acute viral hepatitis had clinical presence of jaundice, raised bilirubin and disturbed liver function tests.

Data Analysis Procedure:

Collected data had been analyzed through SPSS version 12. Mean and standard deviation (SD) was calculated for age. Frequencies as percentages were presented for qualitative variables. Chi-square test was used to compare qualitative variable between both the groups. *P*-value <0.05 was considered statistically significant.

RESULTS

A total of eighty patients were included in this study divided into two groups I and II. Group I consisted of patients diagnosed with acute viral hepatitis whereas group II consisted of normal volunteers. Both groups underwent Doppler ultrasound.

Out of the eighty patients there were 57 males and 23 females. The age of patients in group I varied from 21 to 59 years with mean age of 36.7±11.3 years while in group II age of patients varied from 20 to 58 years with mean age of 34.9±10.8 years. The patient characteristics are shown in table 1.

The pattern of hepatic vein spectral Doppler in the two groups is expressed in table -2. There was significant difference in wave pattern of both the groups (p<0.001).

One patient in group II having abnormal wave pattern later on developed AVH and was treated accordingly.

This showed that the hepatic vein doppler flow pattern has a strong association with acute viral hepatitis and is significantly disturbed in such cases and thus can serve as a strong predictor of the diseased liver as well as can help in differentiating diseased individuals from normal ones.

DISCUSSION

Ultrasound is the initial examination performed in most patients with suspected hepatic abnormality[7]. Interrogation with ultrasound is best performed using a 5 MHz curvilinear probe but in large patients, a low

Table-1: Group Wise Gender distribution of Patients

	Males	Females
Group I (n=40)	27	13
Group II (n=40)	30	10

P=0.459

Table-2: Percentage of Types of Wave Pattern

	Monophasic	Biphasic	Triphasic
Group I (n=40)	30 (75%)	5 (12.5%)	5 (12.5%)
Group II (n=40)	0 (0%)	1 (2.5%)	39(97.5%)

P<0.001

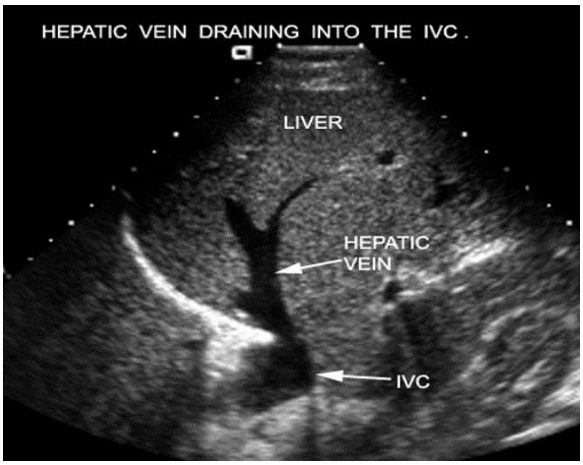

Fig 1: Normal ultrasound anatomy of hepatic veins

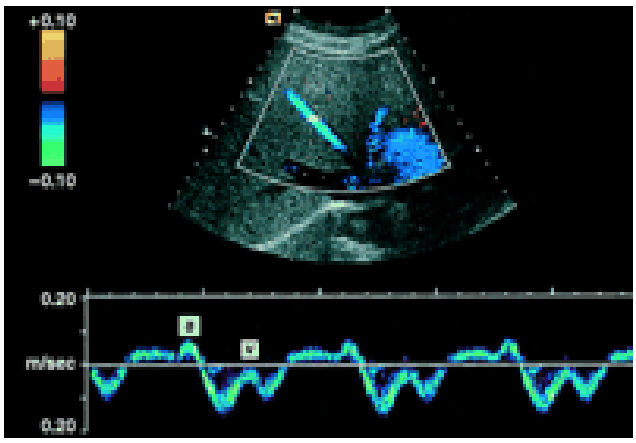

Fig 2: Normal triphasic flow pattern in hepatic veins.

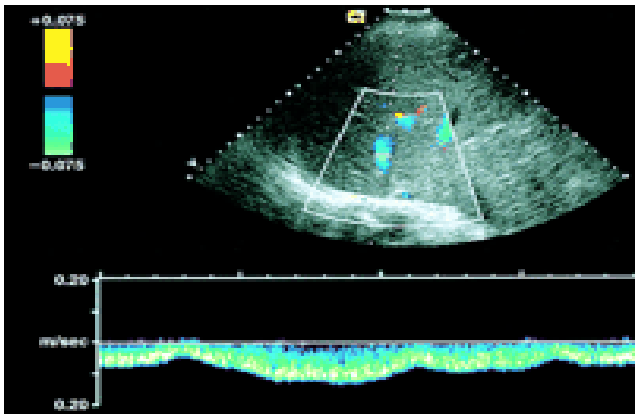

Fig 3: Biphasic flow in hepatic veins

frequency probe may be necessary. The liver is divided into right and left lobes by the middle hepatic vein. Further division into segmental anatomy is achieved by the course of the right and left hepatic veins and porta[8].

The hepatic veins have a characteristic triphasic waveform, which reflects right atrial and inferior vena cava pressure[8].

Hepatic vein flow patterns are under the effects of cardiac function and intrabdominal and intrathoracic pressure.

There is a low-velocity phase of retrograde flow during right atrial contraction (a wave). Two higher velocity phases of hepatofugal flow follow, the first during right ventricular systole after closure of the tricuspid valve, and the second during right ventricular diastole. This rise in atrial pressure interrupts the two periods of forward flow and may produce a short second period of hepatic venous flow reversal, even in healthy patients. V wave flow reversal is almost always smaller than the a wave flow reversal[2,5,8].

A number of conditions can result in the alteration of Doppler hepatic venous flow pattern. Hepatic venous pulsatility may disappear during pregnancy and may remain abnormal even beyond 8 weeks postpartum. Hepatic venous waveforms in pregnant patients may be dampened or monophasic even before 20 weeks gestation, and most patients (80%) have flat waveforms in the final 10 weeks of pregnancy. The precise cause of these changes in pregnancy is unknown, although the altered cardiac output seen in pregnancy coupled with the pressure effects of the enlarged uterus may play a role[9].

Abnormal flow may occur in the hepatic veins if there is abnormal communication between the hepatic veins and other hepatic vessels, right heart pressures are elevated, transmission of the right atrial pressure pattern

is impeded because of venous outflow obstruction or infiltration and altered compliance of the hepatic parenchyma result in dampening of hepatic venous flow patterns. Examples of such pathological conditions include intrahepatic vascular shunts and vascular malformations[10,11] right heart failure[12], Budd Chiari syndrome[13], other veno-occlusive hepatic diseases and Sinusoidal Obstruction syndromes[14], Biliary tract disease and infiltrative tumours[15] as well as benign masses[16].

When the liver architecture becomes less pliant, as in cases of hepatic diseases e.g. acute viral hepatitis, obesity, cirrhosis, ascites, masses, and the presence of increased intraabdominal pressure, a depression occurs in the Doppler wave (biphasic flow pattern), or normal pulsations do not appear (monophasic flow pattern)[17].

In this study we focused on the Doppler pattern of hepatic veins in patients with both clinical and laboratory based diagnosis of acute viral hepatitis. The results supported our hypothesis and showed that 87.5% patients with diagnosis of AVH had abnormal wave pattern in hepatic veins, while in the control group only one patient had abnormal wave pattern in hepatic veins; this patient subsequently had deranged liver function tests and had acute viral hepatitis. We compared the results with well documented international studies and the comparison is given as under.

Jequier[18] et al in a prospective study on 100 healthy children, revealed no significant difference in hepatic wave pattern of normal and hungry children. But he demonstrated that age was a significant factor in most of the newborns where monophasic flow was present. Our study has clearly shown that wave pattern among diseased and control group is a reliable predictor of disease process.

Meyer[19] et al showed that a triphasic pattern is seen in most of the healthy population and we have also demonstrated that the control group has shown a triphasic wave pattern in hepatic veins on Doppler ultrasound.

Arda[20] et al in a double blind study done on 30 patients with early stage chronic liver parenchymal disease and 40 healthy patients using Doppler ultrasound, showed Triphasic wave forms in all of the healthy patients. Of the patients with liver disease, only 26.6% had a triphasic pattern, and the rest had biphasic or monophasic patterns. The results of this study validate the outcome of the research protocol used in our study.

Dietrich[21] et al conducted a prospective study involving 135 patients of chronic hepatitis-C and 75 healthy individuals in which Doppler ultrasound was used to determine the wave pattern of blood flow in hepatic veins. In the diseased group 47% had triphasic, 36% had monophasic, and 17% had biphasic flow patterns; while in the healthy group, 75% had triphasic, 16% had monophasic, and 9% had biphasic flow patterns. These results are similar to the results of this study.

Szekely and Kupcsulik[22] in their study arrived at a conclusion that biphasic wave pattern was seen in patients of acute liver disease and monophasic wave pattern was seen in patients of cirrhosis.

Thus our study has revealed that wave pattern seen in the hepatic veins does change, and serve as a reliable predictor of disease status in individuals of acute viral hepatitis.

CONCLUSION

The results of this study have shown that abnormal wave pattern in hepatic veins did accurately point out the disease process in patients. Colour Doppler ultrasound can thus also be used in routine screening of liver and help in separating diseased liver from the healthy ones. Although this study has included a small number of patients as study group yet the results are in favour of the use of Colour Doppler ultrasound as a screening test in detection of liver pathologies. However further research is required to find a still better method and to perfect this technique.

REFERENCES

1. Teichgraber UK, Gebel M, Benter T, Manns MP. Effect of respiration, exercise and food intake on hepatic vein circulation. J Ultrasound Med 1997;16: 549-54.

2. Jequier S, Jequier JC, Hanquinet S. Doppler waveform of hepatic veins in healthy children. AJR Am J Roentgenol 2000; 175:85-90.

3. Hamato N, Moriyasu F, Someda H. Phase shift of the hepatic vein flow velocity waveform in chronic liver disease: experimental and clinical studies. Ultrasound Med Biol 1997; 23:821-28.

4. Martinez-Noguera A, Montserrat E, Torrubia S, Villalba J. Doppler in hepatic cirrhosis and chronic hepatitis. Semin Ultrasound CT MR 2002; 23:19-36.

5. Blanco JA, Pedregal CJ, Delgado SM. Changed hepatic vein flow in patients with cirrhosis. A Doppler study of hepatic veins in patients with cirrhosis. Rev Esp Enferm Dig. 1995; 87(9):621-3.

6. Killi RM. Doppler sonography of the native liver. Eur J Radiol 1999; 32:21-35.

7. Levy AD. Noninvasive imaging approach to patients with suspected hepatobiliary disease. Techniques in vascular and interventional radiology 2001; 4:132-40.Top of FormBottom of Form

8. Cosgrove DO, Arger PH, Coleman PG. Ultrasonic Anatomy of hepatic veins. Journal of clinical ultrasound. 2005: 15: 231-35.

9. Bozgeyik Z, Ozdemir H, Kocakoc E, Simsek M. Hepatic and portal venous Doppler waveforms and flow velocities in normal pregnancy.. Med Sci Monit. 2009 Dec; 15(12): 624-7.

10. Bolondi L, Bassi SL, Gaiani S. Liver cirrhosis: changes of Doppler waveform of hepatic veins. Radiology 1991; 178:513–6.

11. Colli A, Fraquelli M, Andreoletti M, Marino B, Zuccoli E, Conte D. Severe liver fibrosis or cirrhosis: Accuracy of US for detection - analysis of 300 cases. Radiology 2003; 227: 89–94.

12. O'Donohue J, Ng C, Catnach S, Farrant P, Williams R. Diagnostic value of Doppler assessment of the hepatic and portal vessels and ultrasound of the spleen in liver disease. Eur J Gastroenterol Hepatol 2004; 16:147–55.

13. Herbay A, Frieling T, Haussinger D. Association between duplex Doppler sonographic flow pattern in right hepatic vein and various liver diseases. J Clin Ultrasound 2001; 29:25–30.

14. Nomura H. Sort-term interferon-alfa therapy for acute hepatitis C: a randomized controlled trial. Hepatology 2004; 39:12-18.

15. Webb LJ, Betrger LA, Sherlock S. Grey scale ultrasonography of portal vein. Lancet 1977 : 675-677.

16. Colli A, Cocciolo M, Riva C, Martinez E, Prisco A, Priola M. Abnormalities of Doppler waveform of the hepatic veins in patients with chronic liver disease : correlation with histologic findings. Am Journal of Roentgenology. 1994; 162: 833-37.

17. Farrant P, Meire HB. Hepatic vein pulsatility assessment on spectral Doppler ultrasound. Br J Radiol 1997; 70:829-32.

18. Jequier S, Jequier JC, Hanquinet S, Coultre CL, Belli DC. Hepatic vein Doppler studies: variability of flow pattern in normal children. Pediatr Radiol 2002; 32:49-55.

19. Meyer RJ, Goldberg SJ, Donnerstein RL. Superior vena cava and hepatic vein velocity patterns in normal children. Am J Cardiol 1993; 72:238-40.

20. Arda K, Ofelli M, Calikoglu U, Olcer T, Cumhur T. Hepatic vein Doppler waveform changes in early stage (Child-Pugh A) chronic parenchymal liver disease. J Clin Ultrasound 1997; 25:15-19.

21. Dietrich CF, Lee JH, Gottschalk R. Hepatic and portal vein flow pattern in correlation with intrahepatic fat deposition and liver histology in patients with chronic hepatitis C. AJR Am J Roentgenol 1998; 171:437-43.

22. Szekely G, Kupcsulik P. Ultrasonographic examination of the circulation in diffuse liver diseases. Orv Hetil 1994; 135:2083-86.