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Hepatic vein flow pattern in children: assesment with Doppler sonography

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Abstract

Background: Aim of this study is to establish normal hepatic vein flow pattern and effect of age, sex, activity and feeding status on the hepatic flow pattern in normal Turkish children less than 15 years of ages and also to compare our values with the previously reported studies. *Method:* Hepatic vein flow patterns were evaluated in 150 children (83 male, 67 female) without any cardiac, pulmonary and liver disease by using Doppler sonography. Blood flow patterns were compared with age, sex, activity, and feeding status of the children. *Results:* Only 44% of the children had triphasic flow pattern in all hepatic veins. Monophasic flow pattern was the most common flow pattern in children less then 1 year of age. Triphasic flow pattern increase after 1 year of age. Although most of the children older than 1 year of age had triphasic flow pattern, there is some variation in the flow patterns of the hepatic veins in the same subject. Triphasic hepatic flow pattern is most commonly seen in the left hepatic vein and least commonly seen in the right hepatic vein. There was no significant difference between male and girl, children who were agitated or calm and fasting or not fasting in respect to triphasic flow pattern. *Conclusion:* Liver stiffening is not only the reason for abnormal hepatic flow pattern and some other physiologic factors may also lead to mono and/or diphasic flow pattern in the children. Absence of triphasic flow pattern must not be accepted as a liver pathology in children especially younger than 1 year of age.
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Keywords: Doppler; Hepatic vein; Flow pattern; Children

1. Introduction

Blood flow pattern of the hepatic vein is influenced by the pressure in the right atrium, the compliance of the hepatic parenchyma, and changes in the thoracic and abdominal pressure by respiration [1–5]. Under normal condition, blood flow in the hepatic veins is pulsatile, and changes in the right atrium pressure are clearly reflected in the triphasic wave with “a” and occasionally “v” wave components producing reverse flow. In the presence of normal abdominal and thoracic pressure and normal cardiac function, the main determinant of flow pattern in the hepatic veins is hepatic parenchyma compliance producing triphasic waveform if the compliance is normal. Parenchymal diseases such as cirrhosis or liver transplant rejection decrease the liver parenchymal compliance and alter the normal triphasic flow pattern in the hepatic veins [1,2].

Numerous studies have been carried out to establish the normal hepatic flow pattern of the hepatic veins in the healthy adults [3,5–8]. If hepatic flow pattern is to be used more widely as an indicator of pathology in children, normal hepatic flow pattern must also be established in this age group. There have been a few studies concerning normal range of hepatic flow pattern in healthy children in the literature [9,10]. The aim of the present study was to establish normal hepatic flow pattern in normal Turkish children less than 15 years of ages without any cardiac, pulmonary, and hepatic disease and to investigate the effect of age, sex, activity and feeding status on the hepatic flow pattern.

2. Materials and methods

The study group included 150 children without any hepatic, cardiac or pulmonary diseases (83 boys, 67 girls; age range, 5 days to 16 years; mean age, 4.3 years). Signed informed consent was obtained from the parents of the children after the procedure had been explained. Doppler examinations were performed with a Hithachi EUB 515 (Tokyo,

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Japan) by using 3, 5–7 MHz transducers in supine position. If appropriate Doppler waveform is not obtained in supine position, lateral approach was also used. Right, left and middle hepatic veins were examined at approximately 2–4 cm from the inferior vena cava. Accessory hepatic veins were ignored. After we had longitudinal section of the vessel, then the sample volume of Doppler system was placed in the middle of the vessel, thereafter the spectral waveforms were obtained. The smallest possible velocity scale and the lowest possible wall filter were used. The Doppler ultrasonographic studies were performed in all cases by the same examiner to avoid interobserver variability. As the waveform pattern, rather than absolute velocity was being considered, no attempt was made to correct angle of insonation. In grading of hepatic vein patterns we used the same protocol of Jequier et al. [9] used in their study. Hepatic vein waveform patterns were recorded as triphasic, biphasic and monophasic for each vein. Sonographic flow pattern of the hepatic veins was graded as triphasic when there was return above the baseline of the spectral analysis, biphasic when there was ondulations that did not reach above the baseline and monophasic when there was flat waveform without any phasic oscillations.

One hundred and fifty children were divided into five age groups according to age (group A: less than 1 month of age; group B: between 1 month and 1 year of age; group C: >1–5 years of age; group D: >5–12 years; group E; >12–16 years of age), sex, activity (agitated, calm or asleep) and feeding status (fasting or food intake) (Table 1). Fifty-four of the children were referred for urinary tract disease (26 for urinary tract infection, 20 for microscopic hematuria, 8 for hydronephrosis), 28 for abdominal pain that had normal US findings. Twenty-two of the children were from the healthy children out-patients clinic without any medical problem. Nineteen of the children were referred for the follow up of lymphoma during remission, and sonography revealed no adenopathy or liver involvement. Fourteen of the children were referred for remote oncologic disease. Those 33 children with lymphoma and remote oncologic diseases were in remission without any medication for at least 1 year. Thirteen of the children were healthy volunteers of the employee's children.

Statistical analysis: All the variables and factors including age groups, sex, activity and feeding status of the children, and hepatic vein patterns were evaluated for analysis of variance for repeated measurements. The factors sex (male and female), age groups, feeding status, activity, and hepatic veins (right, left and middle) and their interaction were tested for significance. The results are presented in the box plot (Fig. 1) and include the median (50 percentile), the box (25th and 75th percentiles), and the whiskers (10th and 90th percentiles). All statistical evaluations and graphs were made using SPSS software (SPSS Inc., Chicago, IL).

3. Results

Blood flow patterns were recorded from three hepatic veins in 137 children. Of these 137 children, 61 (44.5%) had triphasic flow pattern in three hepatic veins, 24 (17.5%) had triphasic flow pattern in two veins, 18 (13%) had triphasic flow pattern only in one hepatic vein (Fig. 2). Twenty (14.5%) of 137 children had monophasic flow pattern in all three hepatic veins. Only 2 (1.4%) children had biphasic flow pattern in all hepatic veins and remaining 12 (8.7%) had both mono and diphasic flow pattern (Fig. 3). Triphasic hepatic flow pattern is most commonly seen in the left hepatic vein and least commonly seen in the right hepatic vein. Blood flow pattern is recorded in all middle hepatic veins but 12 left and 3 right hepatic veins. Distribution of the flow patterns of the three main hepatic veins is summarized in Table 2.

Most common flow pattern in children less then 1 year of age is monophasic flow pattern. Eleven (38%) of 29 children less than 1 month of age had monophasic flow pattern and only 6 children had triphasic flow pattern in all hepatic veins and 50–65.5% of the children under the age of 1 month had monophasic flow pattern at least in one hepatic vein. Monophasic flow pattern gradually decreased after 1 month of age. Number of children between 1 month and 1 year of age who had monophasic (7 children) and triphasic flow pattern (7 children) in all hepatic veins was similar to each other.

According to the variance analysis for repeated measurements of the data, only age category showed statistical significant difference with hepatic blood flow patterns ($P < 0.0001$) (Fig. 4). There was no significant difference between age group of E, D, C in respect to hepatic vein flow patterns

Table 1
Shows age, sex, feeding state and activity of the 150 children

Group	Age	Number	Sex		Fasting		Activity	
			Male	Female	Yes	No	Agitated	Calm or asleep
A	<1 month	29	16	13	15	14	10	19
B	1 month to 1 year	32	18	14	17	15	13	19
C	>1–5 years	32	17	15	14	18	11	21
D	>5–12 years	29	17	12	15	14	3	26
E	>12–16 years	28	15	13	9	19	0	28
Total		150	83	67	70	80	37	113

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