ULTRASOUND ASPECTS OF SPLENIC VESSELS IN AGE DYNAMICS

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Abstract: *Measuring spleen vessels velocities involves a high degree of difficulty in children because of the poor cooperation often encountered in current practice and of the small size caliber of these vessels. The study aims at measuring the velocities on the splenic artery, portal vein and splenic vein, calculating the maximum values in age dynamics, as well as at establishing certain relations with the children's age and gender. The study batch comprises 158 children (79 boys and 79 girls) aged between one and 17 years old, residing in the county of Sibiu and ran from January 2008-March 2009 in the Diagnostic and Treatment Centre - "Gensan" SRL, "Astra" Private Clinic, in the city of Sibiu. The results showed that the velocities recorded in the splenic vein and artery are related to the length, transverse diameter of the spleen and to the increase in the child's age; the velocities recorded in the portal vein of children and adolescents increase with age and are related to the velocities in the splenic vein without gender differences. Establishing the velocities of the splenic hilum vessels represents a useful investigation in the morphofunctional assessment of the spleen in children.*

Cuvinte cheie: *ecografie, vase splină, vârstă*

Rezumat: *Măsurarea velocităţilor vaselor splinei presupune un grad sporit de dificultate la copil din cauza colaborării defectuoase întâlnită deseori în practica curentă şi din cauza dimensiunilor reduse ale calibrului acestor vase. Studiul are ca obiective măsurarea velocităţilor pe artera splenică, vena portă şi vena splenică, calcularea valorilor maxime în dinamica vârstei, precum şi determinarea unor relaţii cu vârsta copiilor şi cu sexul acestora. Lotul luat în studiu cuprinde un număr de 158 de copii (79 de băieţi şi 79 de fete) cu vârste între o lună şi 17 ani cu domiciliul în judeţul Sibiu şi s-a desfăşurat în perioada ianuarie 2008-martie 2009 în cadrul Centrului de Diagnostic şi Tratament Gensan SRL, „Policlinica Astra" din municipiul Sibiu. Rezultatele au arătat că velocităţile înregistrate în vena şi artera splenică sunt în relaţie cu lungimea, diametrul transversal al splinei şi creşterea în vârstă a copilului, velocităţile înregistrate în vena portă a copilului şi a adolescentului cresc odată cu înaintarea în vârstă şi sunt în relaţie cu velocităţile din vena splenică fără diferenţe pe sexe. Determinarea velocităţilor vaselor din hilul splenic este o investigaţie utilă în aprecierea morfofuncţională a splinei la copil.*

INTRODUCTION

The new advancements in ultrasound allow measuring certain hemodynamic parameters in assessing the internal organs. These techniques are:(1,2,3) colour coded Doppler ultrasound (colour Doppler), pulsed Doppler ultrasound emission (pulsed Doppler), Doppler ultrasound with colour coding of Doppler signal power (power Doppler), harmonic imaging evaluation.

In the *colour coded Doppler* ultrasound, the transducer is able to simultaneously provide both a two-dimensional image and extended Doppler information. The operator separates a certain region of interest on the two-dimensional image. The major advantage of this technique is the two-dimensional visual information, on the blood flow characteristics. In this mode, sample guiding for the pulsed Doppler method is achieved much faster and the examination time is significantly reduced. The disadvantage of this method is related to the phenomenon of ambiguity (aliasing), plus the high costs of the equipment.

Emission pulsed Doppler (pulsed Doppler) implies that the same transducer to emit and receive ultrasound alternatively, so the emission of ultrasound is made in a pulsed mode.

With this technique, the examiner is able to select in depth the area where the signal is to be recorded from, area called Doppler sample.

For each moment of the Doppler curve, the lowest and the highest speed in the sample can be determined, resulting a spectrum of velocity versus time. Since ultrasound emission is made in a pulsed mode, the two-dimensional ultrasound image obtained simultaneously with the Doppler signal is used for choosing the location of the sample area. This method is called *duplex Doppler ultrasound.*

Pulsed Doppler technique allows examining the blood flow in very limited areas, which can be chosen by the examiner as desired, using the two-dimensional ultrasound image as an anatomic guide. Ultrasound emission being pulsed, the body is subjected to an insignificant incident acoustic energy flow.

The disadvantages of the pulsed Doppler technique are the high frequency of the artifacts, the existence of ambiguity artifact given by Nyquist limit (FRP/2), the high costs of the equipment.

Doppler colour coding technique of the Doppler signal power (power Doppler) considers only the Doppler signal power or intensity.

No speed or direction of blood flow is explored. The method detects the presence of blood flow and the number of

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red blood cells causing the Doppler signal.(4) The information included is monochromatic. The major advantage of this technique is that it has much greater sensitivity regarding the presence of blood flow compared to the colour Doppler technique, and as such, is able to detect slower flows in much smaller vessels. Another advantage is the relative independence from the angle of approach of the vessel, which allows the optimal assessment of the tortuous vascular structures. Also, the power Doppler technique does not present the phenomenon of ambiguity (aliasing).(5) The disadvantages of the method are high sensitivity to tissue movements that can induce multiple artifacts, lack of directionality of the information recorded on the monitor, the difficult exploration of the vascularisation of the deep structures.

Harmonic imaging assessment uses ultrasounds with a certain frequency for emission in the body and analyses the echoes returned to harmonic frequencies (higher or lower) of the emission frequency. The advantages of this method are:(6) complete removal of the background noise and the simultaneous visualization of the blood flow. The disadvantage is the relatively high cost of the technology.

In assessing the spleen in children, the normal values of the hemodynamic parameters of this body must be known, as well as their upper and lower limits.

OBJECTIVES

In the studied literature, (7.8) the information about 2D and Doppler echocardiography in children is lacking regarding the spleen, without having conducted a thorough morphofunctional and hemodynamic study of the spleen vessels.

Because we had at our disposal the appropriate technical means, we measured the physiological, hemodynamic parameters of the spleen in a healthy child, with the following objectives:

1. Measuring the velocities on the splenic artery, portal vein and splenic vein and calculating the maximum values in age dynamics;
2. Determining certain relations according to the found values with the children's age and gender.

METHODS

The study batch comprises 158 children (79 boys and 79 girls) aged between one and 17 years old, residing in the county of Sibiu and ran from January 2008-March 2009 in the Diagnostic and Treatment Center - "Gensan" SRL, "Astra" Private Clinic, in the city of Sibiu.

We obtained the parents' verbal consent and cooperation by sending a letter in which we described the purpose of the study and the benefits on the health of the child.

Children with a two-hour fasting before the examination for children between 0-1 years and at least 10 hours for those aged 1-17 years were taken in the study. Agitated children or those who could not be examined properly were excluded in the study.

The examination was made with a MT Medison 8800 device with possibilities of examination in the 2D mode, second harmonic, colour Doppler, power Doppler and pulsed Doppler 3D. Transducer used was a convex one with variable frequency of 2.5; 2.8, 3, 3.5, 4, 5 mHz, with the possibility of increasing or decreasing the ultrasound sector used in scanning the examined organs, the setting being adjusted to the examined subject.

The children were positioned in dorsal decubitus and in right lateral decubitus. The abdominal organs were fully examined using the standard sections for each organ. For spleen, coronal section for measuring the long axis (length) was performed, respectively the transversal oblique for measuring the transversal diameter, by the left IX, X, XI l intercostal spaces.

For the visualization of the splenic hilum vessels, we used the two-dimensional image associated with the 2nd harmonic, pulsed Doppler and colour or power Doppler. We made the measurement after viewing the hilum and we have adjusted the target volume to the size of the examined vessel. Thus, we determined the maximum speed in the splenic artery, splenic vein and portal vein for each age group and we calculated the mean values for each age group by gender.

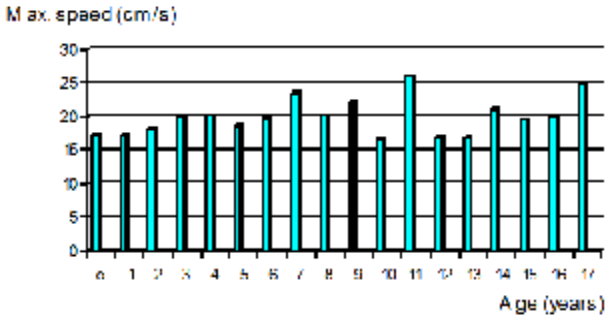
We also studied the relation between the velocities measured for each vessel separately and the length of the spleen, the transversal diameter and the age expressed in years.

The statistical assessment of data was performed with the plurifactorial ANOVA analysis of variance and the Spearman coefficient of relation, with a significance level of $p \leq 0.05$.

RESULTS

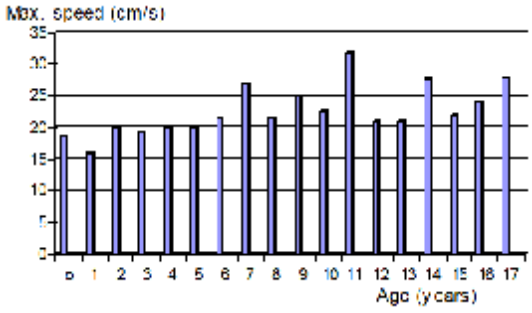
The maximum speed measured in the portal vein increases with the age of the child ($p = 0.007$) (figure no. 1) and closely monitors its growth in length ($p = 0.000$).

Figure no. 1. Maximum velocity measured in the portal vein according to age



The maximum speed measured in the portal vein is in relation with the transversal diameter of the spleen ($r = 0.44$), spleen length ($r = 0.40$), child's age ($r = 0.41$) and its length ($r = 0, 39$). The maximum speed measured in the splenic vein is accelerating ($p = 0.000$) with age ($r = 0.41$) (figure no. 2) and is related to the child's spleen length ($r = 0.40$).

Figure no. 2. Maximum velocity measured in the splenic vein by age

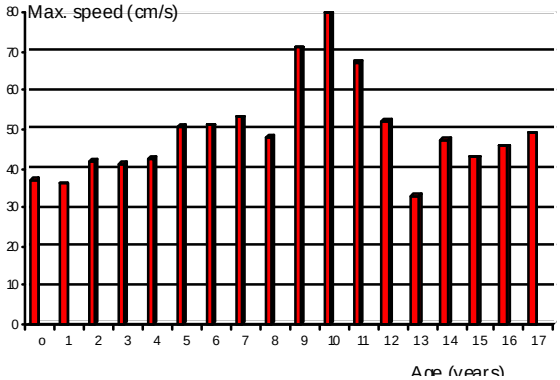


The increase of the velocities measured in the splenic vein is not directly proportioned with the increase in its length. The results are due to the heterogeneity of the batch, certified by the standard deviation. The maximum speed measured in the splenic vein correlated ($r = 0.44$) with the transversal diameter of the spleen. ANOVA ($p \leq 0.05$) analysis of variance indicates

a homogeneous growth rate of the speed in the splenic vein compared with the transversal diameter of the spleen.

The results confirm the homogeneity of the increase of the transversal diameter of the spleen, a parameter correlated with the velocities recorded on the splenic vein, being considered as a reference parameter in spleen measurement. The maximum speed measured in the splenic vein do not differ in terms of gender (p = 0.77). The maximum speed measured in the splenic artery (figure no. 3) increases with child's age and reaches a maximum value at the age of 17 (p = 0.000). It is related to the transversal diameter (r = 0.32) and spleen length (r = 0.35).

Figure no. 3. Maximum velocity measured in the splenic artery by age



The results show oscillations of the maximum speed of the blood flow in the portal vein, splenic vein and artery in relation to the child's age increase, but statistically insignificant. The oscillations of the splenic vein do not correlate with those of the portal vein or with age (table no. 1).

Table no. 1. Variation of velocities measured in the portal vein, splenic artery and vein by age

Age (years)	Maximum speed measured in the splenic vein (cm/s)	Maximum speed measured in the splenic artery (cm/s)	Maximum speed measured in the portal vein (cm/s)
0	18,66 ± 5,502	37,16 ± 4,446	17,33 ± 4,633
1	16,15 ± 2,774	36,00 ± 4,784	17,36 ± 3,218
2	19,75 ± 2,605	41,87 ± 6,600	18,25 ± 2,375
3	19,28 ± 3,904	41,14 ± 8,395	20,00 ± 3,512
4	19,75 ± 6,021	42,50 ± 3,512	20,25 ± 3,304
5	19,83 ± 1,472	51,00 ± 12,522	18,66 ± 1,633
6	21,40 ± 3,307	51,10 ± 9,701	19,60 ± 2,836
7	27,00 ± 10,536	53,33 ± 6,110	23,33 ± 5,033
8	21,40 ± 5,814	48,20 ± 15,320	20,20 ± 5,805
9	25,00 ± 0,000	71,00 ± 0,000	22,00 ± 0,000
10	22,50 ± 3,536	80,00 ± 25,456	16,50 ± 2,121
11	31,66 ± 9,292	67,33 ± 8,737	26,00 ± 4,359
12	21,00 ± 2,828	52,00 ± 29,698	17,00 ± 7,071
13	21,00 ± 0,000	33,00 ± 0,000	17,00 ± 0,000
14	27,66 ± 6,351	47,33 ±15,044	21,00 ± 2,000
15	22,00 ± 6,218	43,00 ± 4,761	19,50 ± 4,796
16	24,00 ± 2,098	45,83 ± 2,229	19,83 ± 4,622
17	27,90 ± 4,841	49,20 ± 7,465	24,90 ± 3,542
	P=0,000	P=0,000	P=0,007

DISCUSSIONS

The results indicate an increase of the velocities in age dynamics as compared to the sizes of the spleen.(9) Although we have achieved children's compliance and we strictly observed the protocol and the standard pre-established sections, the oscillations seen in the maximum speed in the splenic and portal vein vessels may have some errors. In literature, we did not find any references to the speed measured in the splenic hilum vessels in child, which does not allow a comparative orientation. The velocities of the splenic vein are in association with those determined in the portal vein. To consider the observed values as indicative standards would be a hazardous interpretation.

The correlation between the spleen size and the spleen velocities shows that spleen vascularisation is closely related to the morphological growth of this organ. This makes the investigation of the vessels useful in the complete examination of the spleen vessels.

CONCLUSIONS

1. The velocities recorded in the splenic vein and artery are related to the length, transversal diameter of the spleen and to the increase in age of the child.
2. The velocities recorded in the portal vein of the child and adolescent increase with age and are related to the velocities of the splenic vein without gender differences.
3. Determining the velocities of the splenic hilum vessels is a useful investigation in the morphofunctional assessment of the spleen in children.

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