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PRELIMINARY COMMUNICATION

Non-invasive examination of pulmonary stenosis by transcutaneous Doppler technique

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Analysis of the transcutaneous Doppler velocity blood flow curve was performed in a 12 year old girl with pulmonary stenosis. The blood flow indices of the pulmonary artery were compared with those obtained in a control group.

To our knowledge, transcutaneous Doppler analysis of the blood flow curve of the pulmonary artery in children with pulmonary stenosis has not been performed. In the present paper such an attempt is reported.

MATERIALS AND METHODS

The 12 years old girl W.G. had slight pulmonary stenosis confirmed by angiocardiography. The only abnormal value was the right ventricular pressure of 36–40/0 mm Hg. As a control group, 26 healthy children were examined. A Siemens Doppler ultrasound blood flow detector transmitting a continuous beam of 5 MHz was used. A Doppler probe, containing piezoelectric transducers of 16 mm^2 area was applied to the second left intercostal space near the sternum, using an ultrasonic contactant. The purest and loudest sound audible in the loudspeaker was obtained by gently maneuvring the probe. The sound was registered by a three-channel recorder together with the ECG and phono curves from standard limb leads (Fig. 1).

In each child four ultrasound systolic flow complexes of the clearest outline and greatest amplitude were analysed. The measurements performed were (Fig. 2):

(a) indices of blood flow with respect to time (in ms)

1. t_{max} = initial maximal acceleration time: interval between the beginning upslope of the ultrasound systolic wave (s.w.) and the point of projection of the peak of the initial steeper upslope of s.w. (s.u.s.w.) on the baseline
2. t = entire acceleration time: interval between the beginning upslope of s.w. and the point of projection of the peak of s.w. on the baseline
3. PEP = interval between the beginning of the ECG Q wave and the upslope of s.w.
4. t_{max}/t,
5. PEP/t_{max},
6. PEP/t

(b) indices of blood flow with respect to velocity or velocity and time (in irrational units)

1. w/c* ($=V_i'$)
2. w_1/c ($=V_i''$)

* w, w_1, c = amplitude (in mm) of the peak of s.u.s.w., the top of s.w. and one step of the device's scale, respectively (Fig. 2)

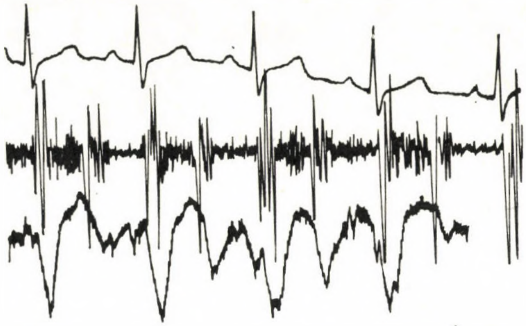

FIG. 1. Doppler velocity blood flow curve of pulmonary artery (below) in patient registered synchronously with ECG and PCG curves

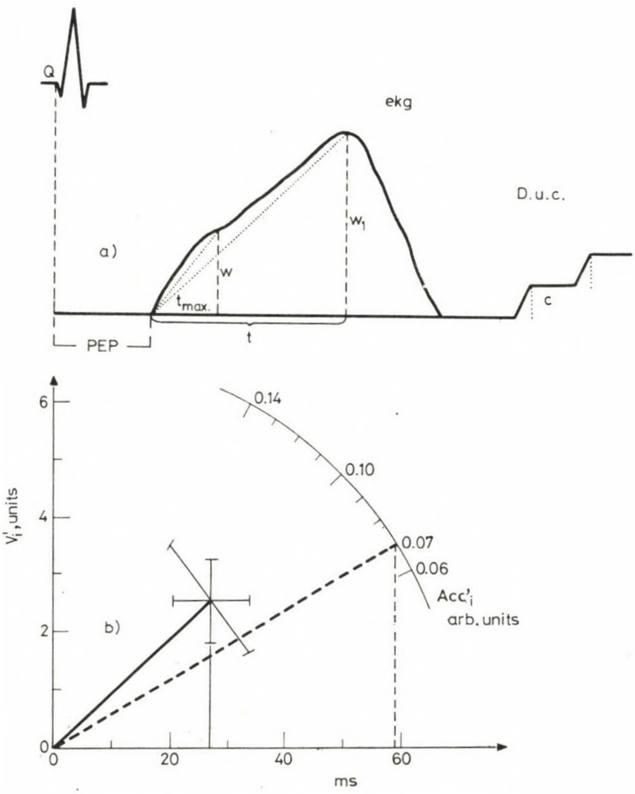

FIG. 2. Panel a: method of derivation of choiced blood flow indices from Doppler curve. Dotted lines represent the approximate values of blood acceleration during t_{max} or t. Panel b: scheme representing the blood flow indices concerning the initial upslope of the Doppler curve. Continuous line (with SD values) and broken line represent the control group and the patient, respectively. Other designations are explained in the text

3. V_i'/V_i'' = instantaneous initial and entire linear blood velocity and their quotient, respectively
4. dV_i'/dt_{max}** ($=Acc_i'$)
5. dV_i''/dt ($=Acc_i''$)
6. Acc_i'/Acc_i'' = instantaneous initial maximal and entire linear blood acceleration and their quotient, respectively
7. $V_i' \times t_{max}/2$ ($=A_i'$)
8. $V_i'' \times t/2$ ($=A_i''$)
9. A_i'/A_i'' = area under the s.u.s.w., under the entire ultrasound flow systolic curve and their quotient, respectively.

Results

The greatest differences (the values above 2 SD of the mean of the control group) between the patient and the healthy children with respect to the value of t_{max} (which was higher in the patient) and some of its derivatives (t_{max}/t, PEP/t_{max}, A_i', A_i'/A_i''), were measured (Fig. 2).

Discussion

Non-invasive techniques such as the ultrasonic Doppler method now gradually replace heart catheterization and angiocardiography [1, 6, 7]. A continuous wave device with broad beam and lack of range-gating as compared to pulsed ultrasonic Doppler techniques, was used in this study. A close similarity between the pulsed and the continuous wave data was regularly found by some authors and the differences appeared to be within the range of normally occurring short-term variations and experimental error [3].

Pulmonary artery blood flow was determined by other authors from the second left intercostal space by means of Doppler devices in newborns, children and adults [1, 2, 7].

Indices with respect to time (expressed in ms) can be obtained from the Doppler curve. The technique, however, offers no possibility to obtain real values for blood velocity in the pulmonary artery, thus in the present paper the indices of that velocity are expressed in irrational units.

In the present study the greatest differences between the indices concerning the initial upslope of the Doppler curve of the patient and the control group were caused by an elongation of the t_{max} which in spite of the greater V_i' caused the comparatively low value of Acc_i' in the patient (Fig. 2).

The other non-invasive method of circulatory system examination, regarded till now as the most precise of all non-invasive techniques, is tetrapolar impedance rheography [4, 5]. Recently, Szafjanski and Palko have performed a quantitative estimation of the blood flow in the right pulmonary artery in children by means of their own method based on the current tetrapolar technique of transthoracic impedance measure-

** measurement of the linear blood acceleration or calculation of indices with respect to the area, was performed by triangular approximation (Fig. 2) ment along the course of that artery [9].

The results presented in this paper concerning t_{max} agree well with those of Szafjanski et al. [8] who examined a few children with pulmonary stenosis by means of their own impedance method.

Further studies will have to decide whether the Doppler method would prove of use in the diagnosis as well as in the quantitative evaluation of pulmonary stenosis.

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