METHODS

New Diagnostic Potentialities of Cardiorespiratory Synchronization in Children

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The study demonstrated that the method of cardiorespiratory synchronization provides valuable information on the nature of arrhythmia and helps to evaluate the regulatory adaptive potentialities of a child. The width of synchronization range and the latency of synchronization at the lower boundary are the indicators of regulatory adaptive potentialities.

Key Words: *cardiorespiratory synchronization; children; regulatory adaptive potentialities of the body*

The phenomenon of cardiorespiratory synchronization consists in follows: in spontaneous reproduction of the respiratory rate, which usually surpasses the initial heart rate, the heart adopts the respiratory rhythm and contracts at the rate of respiration [5].

Previous studies demonstrated that the method of cardiorespiratory synchronization allows to determine the nature of arrhythmias in adults [6] and children [2].

The involvement of the nervous system in the realization of cardiorespiratory synchronization [8] suggests that synchronization parameters depend on congenital properties of the nervous system and its status, which prompted their evaluation in children with different types of the nervous system in stress and disease.

If we regard the type of the nervous system, stress, and disease from the viewpoint of regulatory and adaptive potentialities of the organism, we can admit the possibility of using cardiorespiratory synchronization parameters for their evaluation.

The characteristics of adaptive capacity of personality types in our study were based on conclusions drawn by I. P. Pavlov [4] and Ya. Strelyau [10], in accordance with which the types were subdivided into better adapted (phlegmatics, sanguinics) and less adapted (melancholics, cholerics). Stress and disease were regarded as conditions impairing the regulatory and adaptive potentialities of the body [1,3,9].

MATERIALS AND METHODS

A total of 119 boys aged 12 years were examined. Cardiorespiratory synchronization was carried out in all boys: after ECG and pneumogram recording all children were requested to breathe synchronously with lamp flashes (the rate was regulated by the operator). ECG, pneumogram, and flashes were synchronously recorded using an automated recorder. The duration of the test was 30-60 sec.

The onset of cardiorespiratory synchronization (synchronous cardiac and respiratory rhythms) was determined by equality of *R—R* intervals, distance between identical elements of the pneumogram, and flash marks.

The initial frequency of lamp flashes was set up 5% below the initial heart rhythm. For instance, at initial heart rate of 85 bpm the rhythm of flashes was set up at 81/min. The children breathed synchronously with flashes for 30-60 sec and then resumed free respiration rhythm. After heart and respiration rate returned to the initial level, the frequency of flashes was increased by 5% and the test was repeated.

The rhythm of flashes was increased by 5% in each test until the onset of synchronization of the cardiac and respiratory rhythms. This rate was denoted as

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the lower boundary of cardiorespiratory synchronization and expressed in cardiorespiratory cycles/min. Similarly, the rhythm of light flashes was increased by 5% in each test until this synchronization disappeared. The highest respiration rate (frequency of light flashes) at which cardiorespiratory synchronism was still observed was denoted as the upper boundary of cardiorespiratory synchronism. For example, if synchronism was observed at a rate of 110/min, but was not observed at higher flash frequencies, this value corresponded to the upper boundary, which was expressed in synchronous cardiorespiratory cycles/min. The width of the range was estimated as the difference between the upper and lower boundaries.

In addition to synchronization range, the latency of synchronization at the lower and upper boundaries was determined for all examinees; it was evaluated by the number of cardiac cycles from the start of the test to the onset of cardiorespiratory synchronism.

None of the examinees reported unpleasant sensations during testing by the method of cardiorespiratory synchronization. Breathing became shallow at the rate inducing cardiorespiratory synchronization. The decrease in respiratory volume at high respiration rate prevented hyperventilation and shifts of the acid-base balance [7].

The type of the nervous system in examined children was determined using Isenk testing, the anxiety level in psychoemotional stress was evaluated by Luscher test. The examination stress [11] (annual control work) was used as stress situation.

RESULTS

The range of synchronization and its latency at the lower boundary change in the same direction depending on the regulatory adaptive potential of the child, temperament, and the studied state. Wide range of synchronization and its short latency at the lower boundary indicate good adaptive potential. Deterioration of the regulatory adaptive potential is associated with narrower range and longer latency of synchronization at the lower boundary.

Phlegmatics and sanguinics with their best adapted temperaments exhibited wider ranges of synchronization and shorter latencies at the lower boundary in comparison with melancholics and cholerics (less adapted). The widths of synchronization range were 20.50±1.54 in phlegmatics, 16.30±1.33 in sanguinics, 13.81±1.39 in melancholics, and 11.55±0.84 in cholerics. The latencies of synchronization were 11.50±2.72 in phlegmatics, 8.00±1.08 in sanguinics, 13.31±1.43 in melancholics, and 16.66±4.48 in cholerics.

The range of synchronization decreased in stress and disease (by 6.90±1.13 in stress; $p<0.01$), while the latency of synchronization at the lower boundary increased (by 1.29±1.89 in stress; $p<0.05$). The range was narrower and the latency of synchronization was longer in sick children in comparison with healthy individuals. In healthy children the width of synchronization range was 27.00±0.68 *vs.* 7.44±0.89 in patients ($p<0.01$). The latency of synchronization was 12.50± 2.88 in healthy children *vs.* 13.75±1.57 in patients ($p>00.05$).

Narrowing of the synchronization range and lengthening of its latency correlated with deterioration of the regulatory adaptive potentialities. In children with high level of anxiety in stress the width of the synchronization range decreased and the latency of synchronization increased in comparison with other children by 9.77± -2.68 ($p>0.01$) and 2.55±3.47 ($p>0.05$), respectively.

Hence, cardiorespiratory synchronization is a simple noninvasive method for the diagnosis of regulatory and adaptive potential in children. The width of synchronization range and its latency at the lower boundary are indicators of these potentialities. The width of synchronization range decreases and the latency of synchronization at the lower boundary increases with deterioration of the regulatory and adaptive potential and are directly proportional to the severity of deterioration of the regulatory and adaptive potential.

The use of new diagnostic potentialities of the method of cardiorespiratory synchronization will promote early diagnosis of regulatory and adaptive disturbances and their correction and prevention.

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