PHYSIOLOGY

Cardiorespiratory Synchronism in the Evaluation of Adaptive Reaction in Children

E. G. Potyagailo and V. M. Pokrovskii

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 133, No. 6, pp. 613-615, June, 2002
Original article submitted March 26, 2002

Parameters of cardiorespiratory synchronism were studied in children under conditions of psychoemotional stress. The results indicate that the upper limit of the cardiorespiratory synchronism, synchronization range, and the difference between the upper limit and the initial heart rate are the parameters of synchronism, which allow estimation of the normal adaptive reaction and thus help to evaluate health status in children.

Key Words: *cardiorespiratory synchronism; children; psychoemotional stress*

The notion "health" denotes optimal existence in the environment and material and spiritual satisfaction. Therefore, the possibility of the organism to adapt to various aspects of life is now often considered as a measure of health.

In practical medicine such measurements of health status require reference or normal values of adaptive reactions.

The norm of adaptive reaction, or the range and duration of fluctuations of physiological parameters needed for the maintenance of normal vital activity, should be determined for the most frequent adaptive situations with consideration for child's age [1].

We evaluated normal adaptive reactions in boys aged 12 years by the parameters of cardiorespiratory synchronism (CRS) under conditions of psychoemotional stress (the most typical adaptive situation in children).

CRS manifests as follows: at respiratory frequency surpassing the initial heart rate the heart acquires the respiratory rhythm.

The involvement of different structural and functional levels of the central nervous system in the formation of CRS prompted us to use CRS for evaluation of normal adaptive reaction under conditions of psychoemotional stress [2].

Since psychoemotional stress is "organized" by the nervous system, we hypothesized that it changes the CRS parameters.

MATERIALS AND METHODS

Normal adaptive reaction was evaluated by the results of examination of 31 healthy boys aged 12 years. The study was performed during annual exam. This situation forms a pronounced psychoemotional reaction (examination stress [4,5]) most expressed during examination and directly before it.

In all children CRS [2] and Luscher tests were performed 1 month and directly before the exam. CRS parameters were determined and the normal adaptive reaction in stress was evaluated on the basis of these parameters; Luscher test evaluated the level of anxiety.

CRS test was carried out as follows: after initial recording of ECG and pneumogram the examinee was asked to breathe synchronously to lamp flashes (the rate was regulated by investigator). ECG, pneumogram, and lamp flashes were recorded. The test took 30-60 sec.

Department of Normal Physiology, Kuban' State Medical Academy. ***Address for correspondence:*** pokrovsky@ksma.kubannet.ru. Pokrovskii V. M.

0007-4888/02/1336-0529$27.00

CRS, *i. e.* the state when one heartbeat corresponded to one breath, was identified on the record by equality of *R-R* intervals on ECG, distance between identical elements on pneumogram, and intervals between light flashes.

The initial frequency of flashes was 5% below the initial heart rate, the children breathed synchronously with the flashes for 30-60 min and then returned to normal breathing. After normalization of the heart and respiration rates, the frequency of flashes was set at 5% above the initial value and the test was repeated.

A frequency corresponding to the appearance of the synchronization phenomenon was found in repeated tests with 5% increases in flash frequency. This frequency was denoted as the lower limit of CRS. The next step was to find the frequency of light flashes at which synchronization disappeared; it was done by further 5% increases in flash frequency. The highest respiratory rate at which CRS was still observed was denoted as the upper limit of CRS. Thus the synchronization range was determined and its limits were found. In order to evaluate the synchronization range, the difference between the upper and lower limits was estimated.

In addition, the time of synchronization onset at the lower and upper limits and the difference between the lower limit and the initial heart rate were determined in all examinees. The time before synchronization onset was evaluated in cardiocycles from the start of the test until CRS onset.

RESULTS

Luscher test revealed redistribution of children by the level of anxiety under conditions of examination stress:

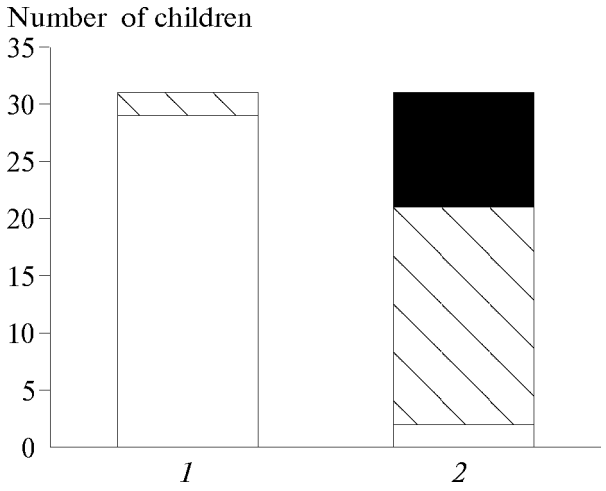

Fig. 1. Distribution of children by the level of anxiety before (*1*) and during stress (*2*). Light bars: low level of anxiety, cross-hatched bars: medium level of anxiety, dark bars: high level of anxiety.

the number of children with low anxiety level decreased, the number of children with medium anxiety level increased, and children with high anxiety level appeared, which confirmed the development of psychoemotional stress (Fig. 1).

Analysis of changes in CRS parameters in stress showed that the upper limit of CRS, range of synchronization, and difference between the lower CRS limit and the initial heart rate changed significantly ($p<0.01$) during stress (Table 1). This substantiates the use of these parameters for evaluation of normal adaptive reaction in psychoemotional stress and health status in children.

Hence, CRS test is a simple noninvasive method for examination and rapid evaluation of the normal adaptive reaction in children.

TABLE 1. Dynamics of CRS Parameters during Stress (*M*±*s*)

Parameter	Value		Δ, abs.
	abs.	% of value without stress	
Initial heart rate, bpm	93.29±2.08	110.14	8.59±1.32*
CRS limits, number of cardiocycles			
lower	96.87±2.04	100.46	—
upper	110.35±2.54	94.32	-6.65±1.78*
CRS range, number of cardiocycles	13.45±1.28	66.09	-6.90±1.13*
Difference between lower CRS limit and initial heart rats, number of cardiocycles	7.42±1.01	61.52	-4.64±0.78*
Delay of synchronization, number of cardiocycles			
at the lower CRS limit	14.93±3.43	109.46	1.29±1.89
at the upper CRS limit	36.90±3.01	91.45	-3.32±4.00

Note. *$p<0.01$ compared to values without stress.

The study was supported by the Russian Foundation for Basic Research (grant No. 97-04-48085).

REFERENCES

1. L. A. Zhdanov and T. V. Rusova, *Ros. Pediatr. Zh.*, No. 2, 52-56 (1999).
2. V. M. Pokrovskii, V. G. Abushkevich, I. I. Borisova, *et al.*, *Kubansk. Nauch. Med. Vestn.*, No. 2, 42-47 (2000).
3. V. M. Pokrovskii, V. G. Abushkevich, and S. V. Shapiro, *Dokl. Akad. Nauk SSSR*, **283**, No. 3, 737-740 (1985).
4. E. A. Umryukhin, E. V. Bykova, and N. V. Klimina, *Fiziol. Chel.*, **22**, No. 2, 108-111 (1996).
5. E. A. Yumatov, V. A. Kuz'menko, V. I. Badikov, *et al.*, *Ibid.*, **27**, No. 2, 104-111 (2001).