

Biorhythmological and Clinico-Functional Features of Arterial Hypertension Under Geoeological Conditions of the North

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Study design: A group of the examined patients with arterial hypertension comprised 412 persons, living under the conditions of the North and the moderate latitudes. 24-hour monitoring of blood pressure (BP) and echocardiography were used. Routine heliogeophysical monitoring was conducted. Heliogeophysical situation at early ontogenesis of the examined was evaluated. Testing magnetic and hypogeomagnetic impacts were used. **Results:** A considerable disorder of the circadian rhythms of hemodynamics manifesting as insufficient decrease of BP at night was revealed in a subgroup of the patients with arterial hypertension living in the North. Using a multifactor analysis, the heliogeophysical patterns of early ontogenesis were revealed in subgroups of the examined with high indices of variability, disorders of the circadian rhythms of BP. A diagnostic test using echocardiography and testing impact by a constant magnetic field was developed to evaluate the hemodynamic reaction to changes of the heliogeophysical environment. While studying the impact of hypogeomagnetic environment on some functional features of the cardiovascular system in the subgroup of patients, it was found that geomagnetic screening caused decrease of systolic arterial pressure, more expressed in "nondippers". **Conclusion:** Thus, some hemodynamic mechanisms of coupling the time organization of cardiovascular system with periodical heliogeophysical variations developed during ontogenesis were defined.

Key words: arterial hypertension, heliogeophysical environment, heliogeophysical imprinting, 24-hour blood pressure monitoring, hemodynamics

INTRODUCTION

Time organization of physiological processes, developed evolutionally, is one of the bases for human health. Among external synchronizers of human functions the heliogeophysical factors are of a great importance [1, 2]. They have an information adjusting impact on the formation of functional systems and strategy of human organism interaction with heliogeophysical environment at early ontogenesis [3, 4]. Peculiarities and evidence of dynamic human organism interaction with heliogeophysical environment during different periods of ontogenesis are marked as «biogeophysical coupling» [4]. The cardiovascular system can be considered as one of its integral indices. We know that the cardiovascular systems play an important role in the physiological processes of adaptation of the human organism to the environment of high latitudes [5, 6]. Ineffective adaptation can lead to the development of arterial hypertension (AH). The prevalence and severity of the clinical course of AH in immigrant population of the North increases. On the whole, among numerous diseases of the blood circulation system arterial hypertension is the leading disease in its prevalence and number of days of temporary disability. It is a significant risk factor for the development of vascular heart and brain affections [7]. AH leads to early invalidism and even mortality of the population. Hence, it is an important indicator of the population health. Unfortunately, the role of such a geoeological factor as the heliogeophysical environment in predicting the risk of occurrence and acute condition of the disease has been poorly investigated. At the same time, the blood pressure dynamics also depends on the state of external factors, in particular, the heliogeophysical medium [8], which plays an important role in the formation of ecology of the North [5].

Extreme conditions of the heliogeophysical medium can cause a deterioration of the state of the cardiovascular system. In the period of an instable geomagnetic field, the state of microcirculation deteriorates, the capillary blood flow decreases, the platelet aggregation enhances, and the process of formation of blood clots accelerates [9]. The sensitivity of patients to changes in the heliogeophysical medium is not uniform. Patients with higher vegetative lability and magnetosensitive patients are more sensitive. Solar activity and the state of the Earth's magnetic field in the period of early ontogenesis can have a significant effect on the peculiarities of reaction of the cardiovascular system to changes in the heliogeophysical medium [4].

New methods of diagnostics and treatment provide an effective help in the efforts to improve the health and life of arterial hypertensives. Now, such methods include 24-hour BP monitoring and echocardiography. The circadian blood pressure profile is considered to be an integral functional characteristic of the cardiovascular system, which reflects the severity and pathogenetic peculiarities of the disease. It is associated with the neuroendocrinal and metabolic status of the patients and the morphofunctional characteristics of the cardiovascular system. On the whole, small variability of the circadian blood pressure profile at arterial hypertension is considered to be an unfavorable prognostic feature [10-13].

In the light of the above data, it is clear that it is important to study in arterial hypertension a possibility of the dynamic correlation between the blood pressure and cardiac rate and the geomagnetic activity and the formation of peculiarities of circadian geodynamic rhythms in such patients.

The purpose of this research was to study some features of influence of the heliogeophysical factors during various periods of ontogenesis on a 24-hour blood pressure profile and functional condition of cardiovascular system in patients with arterial hypertension in the North in terms of clinical features of a current disease.

MATERIAL AND METHODS. STUDY DESIGN

A group of the examined patients with arterial hypertension comprised 412 persons living under the conditions of the North: Megion city, Yakutia (n=368) and the moderate latitudes (Novosibirsk, n=44). The age of the patients was from 18 to 65.

In the investigation the following methods were used:

1. Clinical-diagnostic methods included 24-hour blood pressure monitoring (Bplab, Kardiotehnica 4000BP, Russia) and echocardiography (Aloka SSD 1100, Japan; VIVID 3, USA). In the monitoring, the dynamics of systolic, average dynamic, and diastolic blood pressure, average pressure values in the day and night periods, the nocturnal decline, and the circadian index were taken into account. The state of central hemodynamics was estimated from the data of echocardiography.
2. A computer program called "Gelios – Mlechnyi Put". This program uses a database about the cosmophysical situation in the period from 1900 to 2000. With the help of this computer program, information about the dynamics of cosmophysical factors at any time of human life can be obtained.
3. Monitoring of the heliogeophysical environment (on the basis of the data from orbiting space and ground stations of astronomic and magnetic-ionospheric observation).
4. Estimation of magnetotropic reactions of people with the use of a short-term diagnostic action by a constant magnetic field and hypogeomagnetic impacts were used. The hypogeomagnetic test modeled decrease in value of the horizontal component of the geomagnetic field characteristic of high latitudes.

A complex diagnostic approach permitting to evaluate the dynamic features of functional responses of cardiovascular system to changes of heliogeophysical environment under natural and modeled conditions has been tested.

Statistical treatment of the data was carried out with the help of standard computer software packages Statistica 6.0 and SPSS 9.0. Also, multi-factor analysis with the use of the "solution tree" algorithm in the "LASTAN" computer version developed at the Institute of Mathematics of the Siberian Branch of Russian Academy of Sciences was performed.

RESULTS

A considerable disorder of the circadian rhythms of hemodynamics manifested as insufficient decrease of BP (less than 10%) was revealed in a subgroup of the patients with arterial hypertension, living in the North. No such increase of BP circadian profile disorders was observed under the conditions of moderate latitudes.

In the group of arterial hypertensives living in the North of the Tyumen region (n=317), 155 (48.9%) patients had nocturnal hypertension or insufficient BP nocturnal decline, 136 (42.9%) had physiological BP nocturnal decline. In the comparative group of arterial hypertensives living in the moderate latitudes (Novosibirsk) (n=44), 12 (27.3%) patients had nocturnal hypertension or insufficient BP nocturnal decline, 29 (65.9%) had physiological BP nocturnal decline.

These figures show that the number of failures in the circadian blood pressure dynamics increases (and insufficient nocturnal blood pressure decline prevails) in the subgroup of patients living in the North in comparison to the occurrence of such blood pressure profile in hypertensive patients on the whole. In the literature, this figure constitutes up to 26%. It is necessary to note that in the subgroup of arterial hypertensives living in the North (Yakutia, n=51), but 24-hour BP monitoring in Novosibirsk 16 (31.4%) patients had nocturnal hypertension or insufficient BP nocturnal decline, 30 (58.8 %) had physiological BP nocturnal decline. The group of patients with insufficient nocturnal blood pressure decline had myocardial hypertrophy of the left ventricle much more often (42%) than those with a normal circadian blood pressure profile (22%).

In the subgroup of 119 patients the estimation of correlation between hemodynamic values and geomagnetic activity was made. In case of high coupling of the hemodynamic indices with routine geomagnetic activity (n=58), the circadian rhythms of BP were less evident: a nocturnal BP decline comprised 4.8% in this subgroup. A nocturnal BP decline in the examined without clearly evident "biogeophysical coupling" comprised more than 11%.

A diagnostic test using echocardiography and testing impact of a constant magnetic field was developed to evaluate the hemodynamic reaction to changes of the heliogeophysical environment. In the subgroup of 28 patients based on balance of geomagnetic activity in early ontogenesis and at the test condition, the indices of central hemodynamics such as stroke volume (SV), minute volume (MV), heart index (HI), and specific resistance of peripheral vessels were assessed. It allowed us to describe the hemodynamic mechanisms of magnetotropic reactions at biogeophysical interaction. During the testing, there was an increase in the number of correlations between the indices characterizing the state of the cardiovascular system: the circadian indices of 24-hour blood pressure profile and central hemodynamics (Figure 1), and the state of the heliogeophysical medium in early ontogenesis (Figure 2). This reaction can be considered as a manifestation of adaptation of the cardiovascular system, which is accompanied by an increase of relations in the functional system of blood pressure regulation and central hemodynamics. The use of echocardiography to estimate the reaction of the cardiovascular system to the testing action of a constant magnetic field makes it possible to estimate, in a short time, the individual sensitivity of an organism to ecological factors of heliogeophysical nature, which was formed in ontogenesis.

While studying the impact of hypogeomagnetic environment on some functional features of cardiovascular system in the subgroup of patients (n=28), it was stated that hypogeomagnetic screening caused decrease of systolic arterial pressure, more expressed in "nondippers" (Table I).

Using a multifactor analysis, the heliogeophysical patterns of early ontogenesis were revealed in the subgroup of the examined with high indices of variability, disorders of the circadian rhythms of BP. For each of these subgroups of patients, we determined specific peculiarities of the combination of features of the circadian blood pressure dynamics with the heliogeophysical medium patterns in early ontogenesis (in the process of formation of the anlage and cardiovascular system). Those investigated without the "biogeophysical correlation" had correlations between the circadian blood pressure profile and the solar and geomagnetic activity in the period of early ontogenesis (Figure 3), whereas for those with the "biogeophysical correlation" we observed such correlations only with the geomagnetic activity level in early ontogenesis (Figure 4).

Multi-factor analysis by using the "solution tree" algorithm of the "LASTAN" computer program showed higher systolic blood pressure in the nighttime during 24-hour BP monitoring of the patients with higher geomagnetic activity in early ontogenesis (in the first month after birth) and a less pronounced nocturnal BP decline during the monitoring of patients with a higher level of geomagnetic activity during the first month before the calculated conception date corresponded.

Thus, some hemodynamic mechanisms of coupling of time organization of cardiovascular system with heliogeophysical variations developed during ontogenesis were determined. A biorhythmological role of the geomagnetic field in formation of circadian rhythm of functional features of cardiovascular system was estimated. It confirms the adjusting role of the heliogeophysical factors in the human organism functional integration in ecosystems.

DISCUSSION

Heliogeophysical factors are universal timers. Circadian rhythms of hemodynamics are synchronized with the external conditions of the environment and they are formed under the influence of correlation between metabolic and functional systems of the human organism. The present research shows that influence of heliogeophysical factors at different stages of ontogenesis of the surveyed persons determined in many respects the features of nonspecific reactions to change of magnetic and electromagnetic parameters of environment at various levels. Therefore, biorhythmological role of heliogeophysical factors for cardiovascular system is very important. It is assumed that the modulating influence of geophysical characteristics of the medium like the geomagnetic field on the human organism is partly mediated by the correlation between regulatory processes in the nervous and endocrine systems as well as by the correlation between reductive-oxidative processes in cell membranes. From positions of ecological physiology, consideration of variants of determinant synthesis in the homeostatic systems [14] caused by features of processes of electromagnetic regulation in the organism, appearing in various heliogeophysical situations is possible. Circadian blood pressure variation in arterial hypertensives in the North can be considered as a feature of external and internal desynchronism, which develops at the adaptation to new conditions. Taking into account the fact that in modern biology and, in particular, in biophysics, the optimization of correlation between metabolic processes inside the biosystems plays a special evolutionary role, one can speak about the evolutionary role in the formation of optimal circadian hemodynamic rhythms in humans that live under North conditions. The peculiarities of correlation of the organism with the heliogeophysical medium (diagnosed now by echocardiography and by using partial geomagnetic deprivation) can reveal the forming morphofunctional organization types of a human, which provide optimal adaptation strategies in a dynamically changing environment. The interrelations formed between the biochemical components of the system and its spatial-structural formations, including the cardiovascular system, also can be considered as a coherent behavior. Within the framework of this behavior, there can be consistency between periodic and aperiodic changes inside the system. In accordance with this concept, the sensitivity of highly non-equilibrium states to external oscillations can increase abruptly, and the system response is determined mostly by its state [15]. In this case, one more peculiarity is the enhancement of long-range correlations. This can partly explain the relation between the hemodynamic parameters and heliogeophysical factors of the medium in early ontogenesis. The imprinting mechanism of influence of the heliogeophysical factors during the various periods of ontogenesis at formation and regulation of functional systems is combined with its role in maintenance of conditional afferentation, providing prestarting integration of the nervous - chemical and metabolic processes, preparing the successful action of the functional system [16].

CONCLUSION

It is shown that a decreased amplitude of circadian rhythm of blood pressure, being combined with greater myocardium hypertrophy of the left ventricular and increased sensitivity of functional performances of cardiovascular system to geomagnetic fluctuations is typical of the patients with arterial hypertension, living under conditions of the North.

Based on the multifactor and correlative analyses, the influence of the heliogeophysical factors during early ontogenesis of the examined patients on the formation of functional systems for hemodynamics regulation is shown. A diagnostic test has been developed. Its purpose is to estimate specific individual hemodynamic sensitivity to heliogeophysical factors of the medium using the testing action of the constant magnetic field, echocardiography and short-term partial geomagnetic deprivation. At weakened geomagnetic induction the "nondippers" patients had more manifested modification of blood pressure.

The clinical-diagnostic data of twenty-four hour blood pressure monitoring analyzed jointly with the data of heliogeophysical monitoring make it possible to estimate the functional sensitivity of the human cardiovascular system to geoeological factors of the medium.

Thus, a combination of disorders, of temporary hemodynamic organization with the morphological changes of myocardium and peculiarities of biogeophysical coupling in different periods of ontogenesis of the examined is shown. This approach can be used in diagnostics and treatment of arterial hypertension under geoeological conditions of the North.

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