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RESEARCH OF GEOPHYSICAL AND METEOROLOGICAL FACTORS INFLUENCING A FUNCTIONAL STATE OF CARDIOVASCULAR SYSTEM OF A HUMAN BEING

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Abstract. Within the framework of research project the biophysical monitoring experiment with the purpose to study the effect of environment factors (magnetic disturbances, a change of meteorological parameters, etc.) on a health of people.

In order to achieve the mentioned goal synchronous measurements of a state of cardiovascular system of volunteers at two points of observations (the Yakutsk, Tixie) with the device "Fazagraph" were carried out during the period of October - December 2009.

The analysis of experimental project data has shown that a steady coincidence of geomagnetic disturbance variations with changes of the cardiovascular system index of half of volunteers and a partial coincidence with another half of examined ones who took part in the experiment was found. A similarity between the electrocardiogram indices of examined people and geomagnetic disturbance even at very low values of the geomagnetic disturbance level has been revealed.

Introduction

Changes in space weather affects all the shells of the Earth including the atmosphere and biosphere, mainly through two main channels through changes of short - wave radiation, as well as through changes in the solar wind. From the indicated channels just the change of solar wind parameters (geomagnetic activity) is a biotropic factor that has the greatest effect on the human being [Martynyuk V.S. et al., 2008]. The main target of human exposure is a cardio-vascular system [Breus T.K. et al, 2003], as the most reactive system. It is the first system which joins in the process of adaptation to the extreme conditions [V.I. Rusanov, 1973] and it is manifested by changes in the system of blood circulation, in particular, by the change of vascular wall tension, rheological blood properties and disturbances of relationship of coagulative and anticoagulative systems [N. A. Agadzhanyan, 2001].

The question of nature of the influence of heliogeophysical factors on the human organism, on the physical agent enduring such effect, and on real contribution of external factors into the processes of occurrence and exacerbation of diseases remains open. Therefore, the research of space weather parameters that affect the cardiovascular system of a human being is urgent and timely.

The purpose of this work is to study the relationship of heliogeophysical parameters to a condition of cardiovascular system of a human being.

Experimental data and methods of registration

To implement the above-mentioned aims of study the experiment with the participation of three groups of volunteers aimed to identify the connection of functional state of cardiovascular system of a human being with the changes of geomagnetic activity and meteorological parameters was carried out. The data of the first lead electrocardiograms of the volunteers with the subsequent calculation of T-wave symmetry characterizing the functional state of cardiovascular system of a person as an experimental material were used. As an index of geomagnetic activity the Kp-index was used, and meteoparameters were represented by the ground atmospheric pressure, wind speed, humidity and temperature.

Information on the geomagnetic activity (Kp-index) was obtained from the following site: http://www.wdcb.rssi.ru/stp/data/geomagni.ind/kp_ap/2009.V10. The data of meteorological parameters (humidity, temperature, atmospheric pressure, wind speed) round st.Yakutsk were obtained from the following site: http://meteocenter.net/UEEE_current.htm, the mentioned data round st. Tixie - from http://meteocenter.net/forecast/all.php.

Medical data were obtained during the process of synchronous biophysical experiment at three observation points. The measurements were carried out daily in Yakutsk (62° 2' 0"of northern latitude) at two points: at Yu. G. Shafer Institute of Cosmophysical Research and Aeronomy of SB RAS (IKFIA) and Medical Institute of M. K. Ammosov North-Eastern Federal University (MI), as well as at the observatory of IKFIA in Tixie (71° 38' 12.61" of

northern latitude). Measurements at all three points were carried out during the same time interval using common equipment according a common protocol. All measurements were entered into a common database of the “Geliomed" portal where they were processed by a common method excluding the introduction of subjective factors when local processing of measurements results at the specific points.

The experiment was conducted on a group of volunteers to measure the functional state of human heart with a sensor of the ECG 1-lead (Fazagraf). Such index of the electrocardiogram (ECG) as the T-wave symmetry was used as an index of functional state of the cardiovascular system of person. [Tchaikovsky I. A, Faynzilberg LS, 2009].

The volunteers of 45 persons in number of different age, sex and physical health participated in this experiment. During 3 months, on working days from October to December 2009 every day the researchers measured ECG of subjects with the device "Fazagraf”. ECG data were registered in 4 loads: the 0 load – measurements of cardiac rhythm in a quiescent state, the 1st load - after an exercise which was the same for all participants in the experiment, 2nd load – after the emotional stress, 3rd load - after a 10 minute rest. Thus, an individual set of data for each patient for the entire period of the experiment for each load was obtained. Then, in order to create a continuous number of data the interpolation of indices of each volunteer was carried out.

Results and discussion

Fig.1 presents medical data (coefficient of the T-wave symmetry) for three points of observation for the whole period of experiment In Fig.1 the index of ECG of a person in relative units characterizing the functional state of heart is plotted as an ordinate, the time from the beginning of experiment is plotted as an abscissa.

When comparing the indices of ECG volunteer groups of MI, IKFIA and st. Tixie presented in Fig.1.the researchers found that in the group of subjects of different ages at IKFIA (from 24 to 78 years old) and Tixie (from 22 to 54 years old) had a greater range of variation of the T-wave symmetry than in the MI participant group (from 20 to 21 years old). In the IKFIA group the middle age was 49 years old, in the MI group – 21 years old. In the MI group there were 100% of women and in the IKFIA group there were 40% of men and 60% of women. In the Tixie group the middle age was 36.2 years old including 33.3% of women, 66.7% of men.

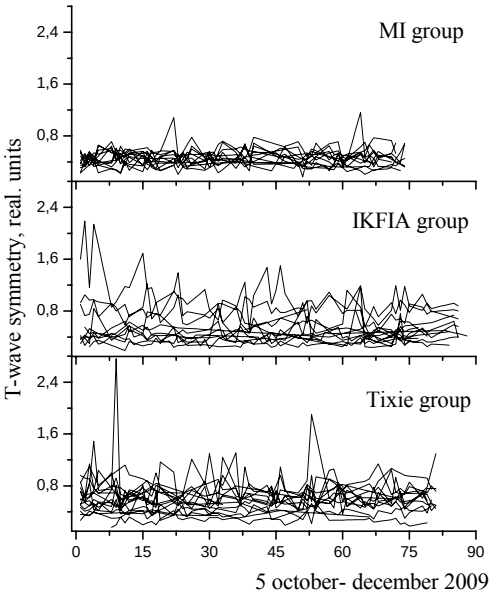

Fig.1. Primary data of the T-wave symmetry of IKFIA, MI and Tixie groups

To find a possible connection between the medical data, geomagnetic disturbance and meteoparameters the interpolated data of all above-mentioned parameters have been filtered with the smoothing period of 4 days. The smoothed data of examinees obtained in such way in 4 loads have been compared with the data of the Kr-index and meteoparameters processed in the same way.

In Figs. 2 and 3. the average index of T-wave symmetry of the electrocardiograms of examinees in relative units and the Kr-index of geomagnetic disturbance is plotted as an ordinate and the time from the beginning of experiment is plotted as an abscissa.

The comparison of temporal variations of T-wave symmetry coefficient (TSC) of each examinee with temporal variations of meteoparameter indices and an index of geomagnetic disturbance has shown a coincidence of these

indices of approximately half of the Yakutsk's examinees. It is found that the best coincidence is observed for the 0 and 3rd modes of the measurements corresponding to the quiescent state and state of examinees after 10 minutes of rest after a physical activity.

A middle age of examinees at Yakutsk with the coinciding changes was 35.1 years old. While the average age of examinees with partially coinciding changes was 48.1 years old.

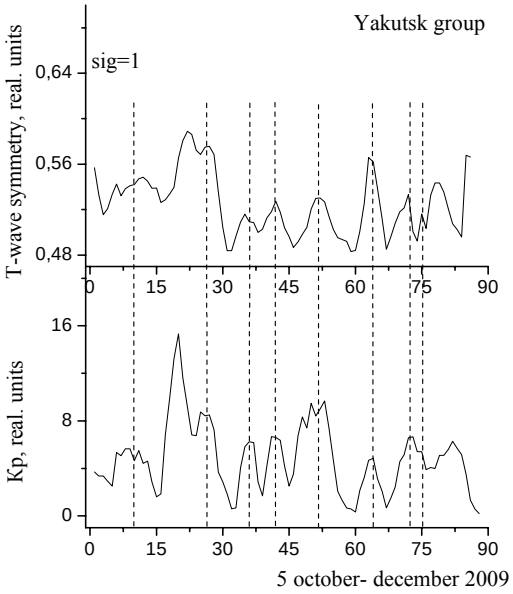

Fig. 2.

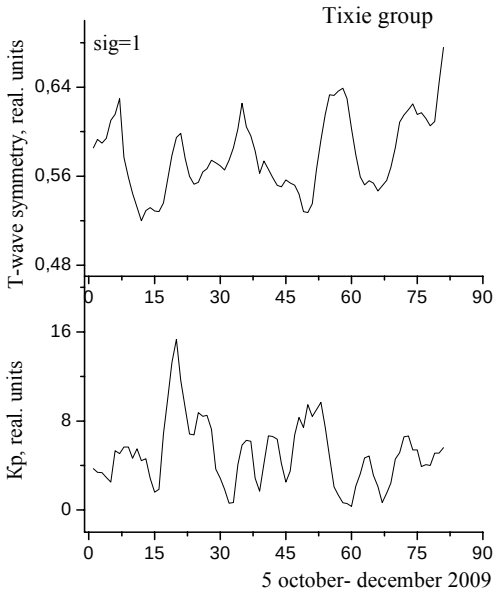

Fig. 3.

Temporal variations of ECG T–wave symmetry coefficient and Kp-index of geomagnetic disturbance

In the group of st. Tixie the middle age of participants with the changes of symmetry of the T-wave of the same type was 31.4 years old , and the average age of participants which not corresponding to the basic change of the medical data was 47.8 years old.

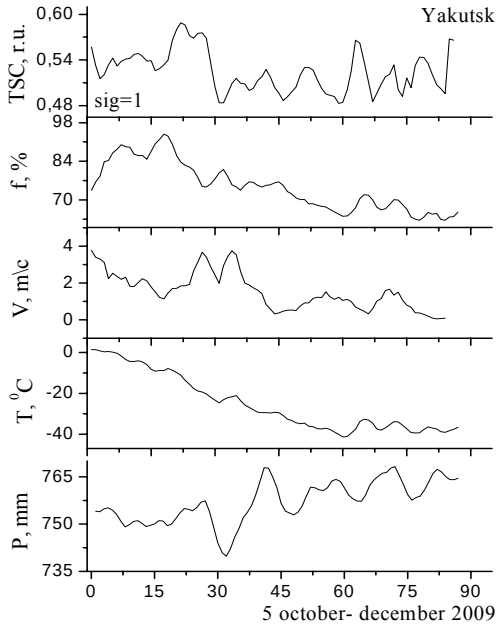

Fig. 4

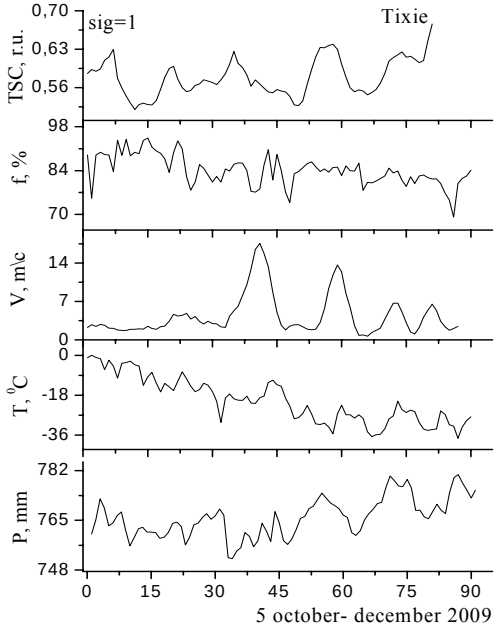

Fig.5

Temporal variations of coefficient of ECG T-wave symmetry with and meteoparameters

It is seen from Fig. 2 that organisms of examinees reply to practically each change of geomagnetic disturbance by the same changes in TSC, and it is observed even despite the nondisturbed level of geomagnetic disturbance. At observation point Tixie (see Fig.3) when comparing the medical and geophysical data the variations of the same type have not been found.

The comparison of changes of coefficient of ECG T-wave symmetry round Yakutsk and Tixie with the meteodata (humidity, temperature, atmospheric pressure, wind speed) is shown in Figs. 4 and 5.

In Figures on the ordinates the variations of meteoparameters and averaged index of ECG T-wave symmetry of examinees in relative units at Yakutsk and Tixie are plotted and on the abscissa the time from the beginning of experiment is plotted.

When comparing slow changes of the index of coefficient of ECG T-wave symmetry round Yakutsk and Tixie with the meteodata the similarity has not been found.

Conclusions

1. In the examinee group of different age a big interval of change of T-wave symmetry than in group of participants of the same age is observed.

2. A steady effect of geomagnetic disturbance on a cardiovascular system of half of volunteers (at the observation point of Yakutsk) taking part in the experiment even at very low values of the level of geomagnetic disturbance has been found.

3. The change of meteoparameters at the points of observation hasn't shown a stable relationship to the state of cardiovascular system of a person.

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