

POSSIBLE SPACE WEATHER INFLUENCE ON FUNCTIONAL ACTIVITY OF THE HUMAN BRAIN

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ABSTRACT

An influence of geomagnetic storms on the integrative human brain system is investigated. The Holter method of electroencephalographic (EEG) registration and vegetative sphere investigation method were used for the persons in healthy condition. Experiments were carried out during both geomagnetically quiet and disturbed conditions. Obtained results show that geomagnetic storms have an influence on human body affecting the functional activity of the brain, particularly, infringing the balance of synchronic and non-synchronic systems, ergo (activating) - and trophotropic (braking) episegmentary vegetative centers. Geomagnetic disturbances may change the background state of brain and infringe adequacy of reaction (respond) in the passage to active state.

1. INTRODUCTION

Our increasingly technology-dependent world is sensitive to solar activity, to changes in this activity and their manifestations in the Earth. We have just passed the maximum of the current 11-years' solar activity cycle # 23. If we are to understand the relationships between solar activity and its possible effects, we need to have a clear understanding of weather processes in space. Space Weather not only affects the functioning of technical systems in space and on the ground, but may also endanger the biosphere. The effects of Space Weather phenomenon are many and varied: they include electronic and power transmission failures, interruptions in telecommunications and navigational systems, hazards to astronauts, aircraft crews and passengers, disruption of oil-gas pipeline, railway traffic, etc. [1].

One of the important effects is an influence of the Space Weather on human health and life, on different biological and physiological systems. There is a number of works dedicated to investigation of these kinds of influences. It is established that at least 75% of magnetic storms are followed by an increase of averagely by 1.5 times of the number of hospitalized

persons with cardiovascular and nervous diseases (myocardial infarction – lesion of muscles of hart, injury of brain vascular, suicide attempts, etc.). An investigation of a blood of tested patients gave interesting results. The viscosity of a blood during magnetic storms increased sharply (in some cases almost twice), the erythrocytes became adhesive, and the blood stream was slowed down. Thereby it is demonstrated that magnetic storms increase risk of development of morbid of cardiovascular system [2,3]. Magnetic storms cause cardiac rhythm malfunction of cosmonauts in the orbital station in extreme conditions [4]. Researches, conducted simultaneously at different geographical regions of the globe, have revealed that during magnetic storms there take place monotype changes in state of mentally ill patients. It is curious that with increase of disturbance of geomagnetic field, the number of epileptic attacks decreases.

Not only central, but also the vegetative nervous system of human is very sensitive (responsive) to geomagnetic disturbances. It is established that during weak and moderate magnetic storms, a tone strengthens in the field of *sympathetic* part (section) of a vegetative nervous system. Only in some cases and, most often for the men, the strengthening (amplification) of tone of the *parasympathetic* section of a vegetative nervous system is observed [5].

On the base of EEG researches it is established that the nervous system of patients responds on geomagnetic disturbances by diphasic reaction [6]. At the day with a magnetic storm the generalized reduction of indexes of spatial synchronization of EEG is marked while at next day, to the contrary, generalized increase as contrasted to long-lived quiet period is registered.

It should be noticed that only few papers are dedicated to analysis of the influence of Space Weather (especially geomagnetic disturbances) on the bioelectric activity of human brain by the help of EEG.

Nevertheless, there are evidences that the nervous system is a target and/or messenger at effecting of fluctuations of a geomagnetic field on physiological states of the human and, particularly, on functional states of the human brain. Therefore, in this paper the results of EEG investigations are used as the most objective method reflecting functional states of the human brain.

2. EXPERIMENTAL METHODS

An investigation of bioelectric activity of the human brain is one of the most perspective methods of analysis of the functional condition of an organism. The intrusion of modern computer methods in the collecting and analysis of data brings new capabilities in study of functions of human brain.

Holter method was used in our experiments to record the bioelectrical activity of brain with subsequent processing of data by the help of special software. Holter method allows conducting investigations of free behavior of the tested person at implementation of a routine activity. This kind of long-time monitoring of the EEG in contradiction to methods of short-time data collection creates broad exploratory capabilities permitting to analyze activity of a brain continuously at different functional and mental conditions during all diurnal cycle "wakefulness - sleep".

Data record is made with the help of a diminutive portative magnetograph, which is the multi-channel digital recorder intended for polygraph registration of the physiological characteristics. The small-sized device fastens by a special way on clothes of the tested person and allows conducting registration in conditions of free movement. The digital data is recorded on a small hard disk "ATA PC Card", which is subsequently subjected to reviewing and analyzing qualitatively and quantitatively.

Five men (age's 19-25 years) participated in our experiments. Registration of spontaneous EEG by a monopolar way from 16 standard leads arranged pursuant to an international system of "10-20" and a parallel registration of the electrocardiogram was conducted. The experiments were carried out in the standard system, mainly between 12-16 o'clock LT (GMT + 4 hours) in the afternoon.

Investigations were carried out for quiet and active awakers in conditions with open and closed eyes, in the state of mental stress (strain) and process of a hyperventilation (intensive breathing) of lungs. The obtained data were subjected to the computer analysis using the software "CONAN", spectral and amplitude

mapping, correlation and periodical-metric analyses were carried out. Experiments were conducted taking into account solar and geomagnetic activity. As the most effective parameter of the geomagnetic activity for biomedical problems is the *Ap*-index, we have used it in our researches.

Reaction of a vegetative nervous system to geomagnetic disturbances was also investigated by means of measurement of pulse (sphygmus), arterial pressure and tests on vegetative reactivity.

For each man under the test, native records of EEG were obtained at different functional conditions. These records, after removal of artefact (hindrance) segments, were analyzed by computer software. Processing of the EEG gave definite results reflecting features of functioning of the brain in relatively geomagnetically quiet and unfavorable (with magnetic storms) days. Thanks to the Holter method, the frequency, amplitude and correlation cartograms for different functional conditions were obtained.

3. RESULTS AND DISCUSSION

Examples of the brain EEG of adult patient recorded at both geomagnetically quiet and disturbed days can be seen in Figs.1 - 2 and Figs. 3 - 4, accordingly. For a comparison, records are provided reflecting for both mentally quiet (Figs.1 and 3) and strained (Figs. 2 and 4) states of the tested person. Simultaneous electrocardiograms (ECG) are located at the bottom of each record. At the left column relevant 16 leads (brain fields) of EEG (Fp1, Fp2,..., T6) are marked. Figs. 3 and 4 reveal an increase of alpha-rhythm amplitude and presence of slow wave effects.

In general, contrary to records conducted at favorable days, an increase of excitation of cortical (bioelectrical) activity is marked during geomagnetically disturbed days in a state of rest. Strengthening of manifestation of high-frequency component clearly appeared on the spectrograms and frequency cartograms. At the same time, the decrease of alpha-rhythm index, some delay of its frequency and, in some cases, sharpening of the shape was marked. Meanwhile, the data of amplitude mapping showed an increase of amplitude of the fast and slow waves.

On some pairs of leads, the inter-parencephalon asymmetry (P3, P4; F7, F8) was marked on the base of amplitude characteristics. The results of correlation analysis indicated the strengthening of inter-parencephalon and intra-parencephalon synchronism during active behavior that reflected amplification of synchronizing messages of nonspecific systems to

cortical areas [7], and gave evidence on inadequacy of responding / effacing of mechanisms of local regulation.

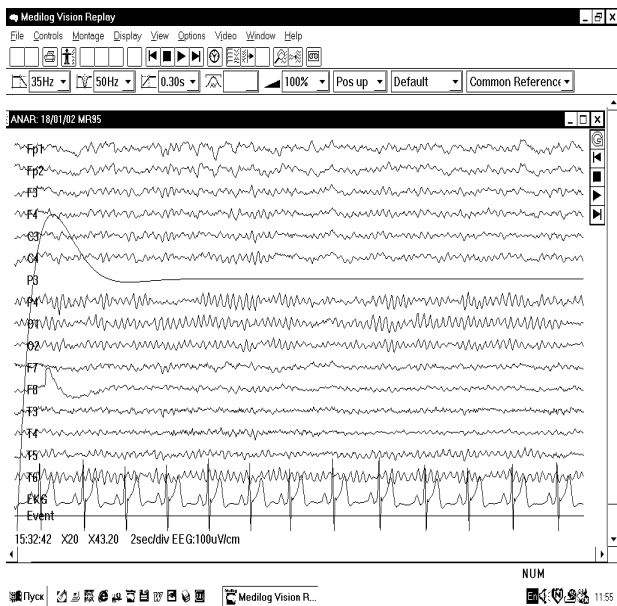


Fig. 1. EEG recorded at geomagnetically undisturbed day (18 January 2002) in mentally - physically quiet state of the tested person.

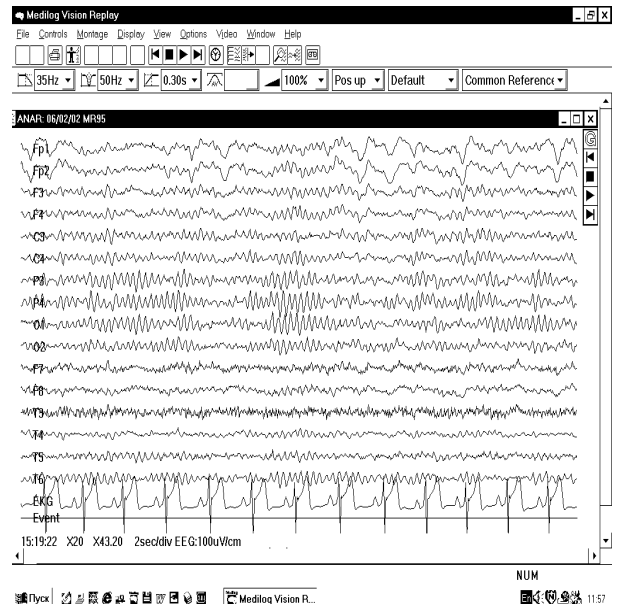


Fig. 3. EEG recorded at geomagnetically disturbed day (06 February 2002) in mentally - physically quiet state of the tested person.

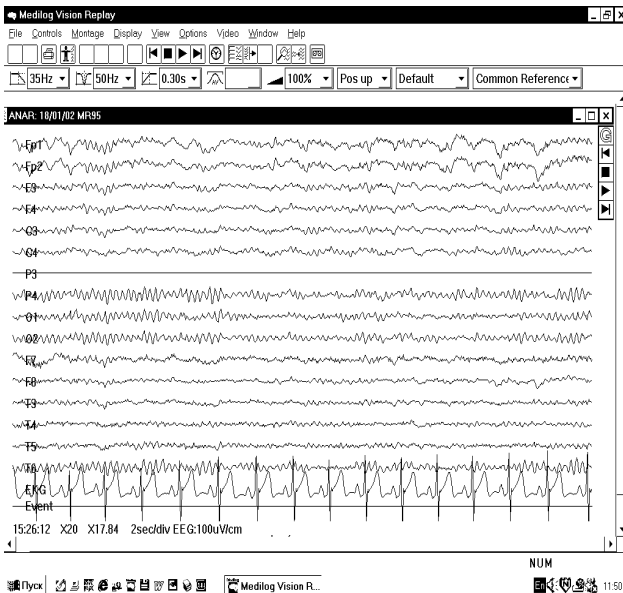


Fig. 2. EEG recorded at geomagnetically undisturbed day (18 January 2002) in mentally – physically strained state of the tested person.

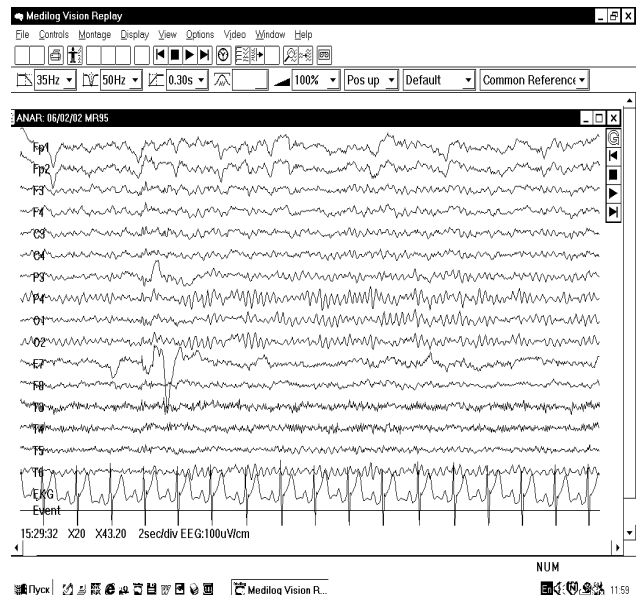


Fig. 4. EEG recorded at geomagnetically disturbed day (06 February 2002) in mentally-physically strained state of the tested person.

state of the tested person.

For some persons under the test, at geomagnetically unfavorable days, the soldering and discharges with the locus of activity in antero-temporal and frontal areas, bearing from time to time bilateral or lateral nature, were registered. It should be noted that the tested persons referred to the group of practically healthy men and did not present any serious complaints. The detected focal changes had an unstable character and in the favorable periods they were leveled which gave evidence in favor of functional genesis of changes and in the absence of structural violations.

At investigation of reaction of the vegetative nervous system, alike the commonality of mechanisms of reacting on magnetic storms (at cortical level), the essential personal variations in descending messages (sending) of vegetative centers are detected. It is observed at both decreasing and increasing of frequency of cardiac pruning, changes of arterial pressure (increase or decrease from the norm), and also in cases of absence of reliable reaction.

The tests on vegetative reactivity indicated “multi-directivity” of reactions. Thus, different types of reactions were observed: excess, failure and uncertainty. All these gave evidence about the dysfunction of episegmentary (located at the brain) vegetative centers, about the misbalance of ergo- and trophotropic mechanisms, and about non-coordinating of ascending and descending messages (sending) [8].

4. SUMMARY

Obtained preliminary results allowed to conclude that the disturbances of the geomagnetic field can affect human organism, having an effect on functional activity of a brain, changing its background state and infringing the adequacy of reacting (respond) during transition from test phase to “normal” activity, particularly infringing the balance of synchronic and non-synchronic systems, ergo (activating) - and trophotropic (braking) episegmentary vegetative centers. These changes are most likely connected to the dysfunction of central integrative brain apparatus accompanied by the strengthening of activating systems and by insufficiency (deficit) of inhibiting mechanisms. Dysfunction affects, in turn, episegmentary vegetative centers, which are followed by the non-adequacy of vegetative securing of the routine activity.

The prophylactic methods are developed which include medical and psychological treatments (warnings, medicine, “active” relaxation, etc.).

Study of geomagnetic activity effects has practical importance for human health. The study of the 11-year variability of the geomagnetic activity shows peaks shortly before and about 2-3 years after sunspot maximum. Therefore the coming next years 2002-2003 will bring another good chance for studying this influence deeply. Improved early warning of impending hazards from space is also needed.

5. ACKNOWLEDGMENTS

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6. REFERENCES

1. *Space Storms and Space Weather Hazard*, Ed. Daglis I.A., NATO Science Series, Vol. II/38, Kluwer Academic Publishers, Dordrecht, The Netherlands, 482 P., 2001.
2. Oraevsky V.N., et al. Medico-Biological Effects of Natural Electro-Magnetic Variations, *Biofizika*, Vol. 43, 1998.
3. Oraevsky V.N., et al. An Influence of Geomagnetic Activity on the Functional State of Organism, *Biofizika*, Vol. 43, 1998.
4. Petrov V.M., et al. An Influence of Changes of Magnetic Field of the Earth on the Functional State of Human in the Conditions of Space Mission, *Proc. Int. Symposium “Computer Electro-Cardiograph On Boundary of Centuries”*, Moscow, Russian Federation, 27-30 April, 1999.
5. Mizun Yu.G. and Mizun P.G., *Space and Health*, Moscow, “Znanie”, 1984.
6. Belov D.R., et. al., Diphasic Reaction of Neural System of the Person on Geomagnetic Storms Under the Data of EEG, *Russian Physiological Journal*, Vol. 87, 2001.
7. Allahverdiyev A.R. Ontogenetic Features of Nonspecific Systems of a Brain in the Norm and at Neurosis, *Auto-essay of Doctoral Thesis*, Moscow, 1989.
8. Allahverdiyev A.R. *Age Features of Nonspecific Systems of a Brain of Children of School Age in the*

*Norm and at Neurosis in a Cycle of Wakefulness –
Sleep, Baku, 1995.*