

Influence of geomagnetic storms on the quality of fulfillment of sensomotor task

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ABSTRACT

Object of the work: Observations were made among the volunteers young men of the age of 18-22 years old (n=84). As geomagnetically quiet were considered the days when the value of the K-index was less than two, and as a geomagnetic storm – when the K-index was equal to 5 and more. The whole contingent was examined in the days of geomagnetic serenity as well as during the storm days. Sensor and motor reaction was studied by means of the Landolt's rings in the computerized regimen: on the blank monitor the rings with 3 or 5 slits appeared, the time of exposition – 36 ms, length of the interval between shots – 1800 ms. The meaning of the task was that object of investigation should to reply on the appearance all light stimulus by simple click on the left knob of the mouse. During each signal the computer program besides the RR-intervals registered also the time of reaction, the quantity of right, wrong and missed responses (i.e. index of the work quality). In the days of a geomagnetic quiet the facts of the wrong responses on the light stimulus were not be fixed; in the geomagnetic storms the worsening of the quality of task performance determined as a appearance of the missed shots and lengthening of the time of reaction was observed. The results received give the base to assert that geomagnetic storms diminish the quality of performance of visual-motor task among the persons with the predominance of the parasympathetic autonomic reactions. Taking into account that the magnetic fields of the infralow and very low frequency ranges influence the autonomic regulatory mechanisms of an organism, alteration of the quality of the performance of magnitolabile persons notes on the alteration of sensitivity of the high, cortical parts of the nervous system toward the geomagnetic storms. Probably this fact can explain the raise of autocatastrophes in the conditions of magnetic non-stability.

KEYWORDS: *geomagnetic storm, sensomotor task*

Recently, for the investigation of the influence of geomagnetic storms on the human organisms methods of functional diagnostics are employed more broader [1,2].

The latest investigations have showed the availability to use the spectral analysis of the heart rate as an informative marker for the assessment of the state of autonomic regulatory mechanisms of an organism and their alterations in the result of the influence of various external stimulus (sound, electromagnetic field etc.) [3,4,5,6].

Object of the work: assessment of autonomic regulatory mechanism of practically healthy young men performing the sensoromotor task during the days of geomagnetic composure and geomagnetic storms.

Observations were made among the volunteers young men of the age of 18-22 years old (n=84). As geomagnetically quiet were considered the days when the value of the K-index was less than two, and as a geomagnetic storm – when the K-index was equal to 5 and more. The whole contingent was examined in the days of geomagnetic serenity as well as during the storm days.

For the legitimation of the investigation and for the complex examination of the health state during the selection of the objects of the observation the questionnaire composed by us was filled in, the basic physiologic parameters were studied and assessed (pulse, arterial tension, the rate and depth of the respiration), the working capacity was defined by the standard graded exercise method of Martine-Kusheliovski.

As a result of the latter form the whole mass of volunteers in the investigating group were included 59 young men (70,2%); the state of the health of others did not allow to defined them as suitable for the control group.

The investigation had the voluntary basis and it was conducted by the binary blind method; not proband nor investigator had not the information about the condition of geomagnetic field during observation as well as about the content of investigation.

Autonomic regulatory mechanism of an organism were evaluated by means of variational pulsometry [7]. The data of variability of the heart rate were proceeded according to standards proposed by Baievski R., Ivanov G., European Society of Cardiology and the Society of Electrophysiology of the North America [7,8].

The investigation began after the instruction of the examining person. The heart rate variability was evaluated in the state quiet and saturation – after 1-1.5 h after the typical for each person mixed breakfast. Also, by means of the questioning was determined that the live regimen of the subjects of investigation (diet, alcohol, physical and emotional strain) was not overloaded at least during the last three days. The investigation was conducted at 10-11 in the morning in the conditions of comfort temperature (20-22°C), normal humidity and atmospheric pressure (there was not observed the atmospheric front intrusion, geomagnetic situation was determining by means of an appropriate web-page).

The five minute registration of RR-intervals of ECG was defined by the necessity of fixation minimum 250 cardiac cycles: it's known that the numbers spectral analysis and counting the Furie's distribution digital line has not been less than 250.

By spectral analysis of biosignals three frequency strips were marked out: a) High Frequency (HF) range – respiratory waves, in norm it ranges in the limits of 1,5-10%; b) High Frequency (HF) range, they also are called vasomotor waves, in norm it ranges in the limits of 15-40%; Very Low Frequency (VLF) range, in norm it ranges in the limits of 15-30%. The indices noted above allow to

receive their derivatives also – the index of centralization $IC=(HF+LF)/VLF$ and index of vagosympathetic interaction LF/HF [9].

Sensor and motor reaction was studied by means of the Landolt's rings in the computerized regimen: on the blank monitor the rings with 3 or 5 slits appeared, the time of exposition – 36 ms, length of the interval between shots – 1800 ms. The meaning of the task was that object of investigation should to reply on the appearance all light stimulus by simple click on the left knob of the mouse. During each signal the computer program besides the RR-intervals registered also the time of reaction, the quantity of right, wrong and missed responses (i.e. index of the work quality).

In the result of the analysis the investigated persons was divided into three groups: I group – with a balanced vagosympathetic equation, II group – predominantly with parasympathetic level of regulation, III group - predominantly with sympathetic mechanisms of regulation. It should be emphasized that noted above is the result of investigation during quiet magnetic days and so the data can be considered as a basic control. Then according to the algorithm of the investigation and the results of an autoreactivity each group was subdivided into two subgroups: the persons investigated in the days of a geomagnetic storms who did not show any alterations of the indices of vagosympathetic equation (I-I, II-I, III-I) and the persons investigated in the days of a geomagnetic

storms who has shown the alterations of the indices of vagosympathetic equation, i.e. who revealed the magnetolability (I-II, II-II, III-II).

As we have already noted the performance of the simple sensomotor task was evaluated by the quantity of errors made and time of reaction (minimal, mean and maximal) during the supplying with light stimulus.

In the days of a geomagnetic quiet the facts of the wrong responses on the light stimulus were not be fixed; in the geomagnetic storms the worsening of the quality of task performance determined as a appearance of the missed shots and lengthening of the time of reaction was observed (Tab.1).

The results received give the base to assert that geomagnetic storms diminish the quality of performance of visual-motor task among the persons with the predominance of the parasympathetic autonomic reactions. Taking into account that the magnetic fields of the infralow and very low frequency ranges influence the autonomic regulatory mechanisms of an organism [4,5], alteration of the quality of the performance of magnetolabile persons notes on the alteration of sensitivity of the high, cortical parts of the nervous system toward the geomagnetic storms. Probably this fact can explain the raise of autocatastrophes in the conditions of magnetic non-stability.

	Wrong responses	Missed responses	Time of reaction	Min time of reaction	Max time of reaction
I Group (n=19)	0	0	450±46,2	270±27,5	850±49,3
I-I subgroup (n=10)	0	1±0,7	440±33,9	255±38,1	845±47,4
I-II subgroup (n=9)	0	3±0,9	320±36,8	262±45,3	885±51,2
II Group (n=23)	0	0	430±29,7	286±42,1	850±49,7
II-I subgroup (n=14)	0	4±1,36	435±34,1	295±38,6	882±38,1
II-II subgroup (n=9)	0	10±1,27	305±40,3	164±29,9	840±44,5
III Group (n=17)	0	0	400±29,9	280±34,6	830±54,2
III-I subgroup (n=10)	0	3±1,12	440±37,3	320±37,5	805±47,1
III-II subgroup (n=7)	0	0	355±34,5	330±41,1	805±39,9

Tab.1 The quality of performance of sensoromotor task.

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Влияние геомагнитных бурь на качество выполнения простой сенсомоторной работы

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Р Е З Ю М Е

Исследовано 84 юношей добровольцев (n=84) в возрасте от 18 до 22 лет. В геомагнитном отношении спокойными считались дни при минимальных значениях К-индекса до 2, а дни с магнитными бурями - при значении К-индекса 5 и выше. Весь контингент обследован и в магнитноспокойные дни, и при магнитных бурях. Сенсорно-моторная реакция изучалась с помощью колец типа Ландольта в компьютерном режиме: на темном фоне экрана появлялись кольца с тремя или пятью разрезами; экспозиция кадра – 36 мсек; длительность, интервала между кадрами – 1800 мсек. В соответствии заданием обследуемый должен был ответить на появление всех световых стимулов одноразовым нажатием на левую кнопку «мышки». Компьютерная программа при каждом сигнале, помимо RR-интервала, регистрировала также время реакции, количество правильных, неправильных и пропущенных ответов; учитывались показатели качества работы. В магнитноспокойные дни неправильные ответы на световой стимул отсутствовали; при магнитных бурях качество выполнения задачи ухудшалось: отмечались т.н. пропущенные кадры и увеличивалось время реакции. Полученные результаты позволяют заключить, что геомагнитные бури снижают качество выполнения зрительно-моторной работы преимущественно среди лицами с преобладанием парасимпатических вегетативных реакций. Учитывая, что магнитное поле инфранизких и очень низких частотных диапазонов воздействуют на вегетативные регуляторные механизмы организма, изменение качества "работы" магнитнолабильных лиц следует расценивать как изменение чувствительности высших, корковых отделов нервной системы к геомагнитным бурям. Повидимому, этим и объясняется повышение числа автокатастроф в магнитнонестабильных условиях.

Ключевые слова: геомагнетический шок, сенсомоторная работа