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Influence of the geomagnetic activity on the human functional systems

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Abstract: *Changes in the normal functioning of the central nervous system, vegetative nervous system, cardiovascular system and cognitive performance may be enhanced by significant variations of the geomagnetic field (GMF) elements. Human physiological, psychophysiological and psychical processes and sensory abilities may be substantially influenced by these changes. The interest in revealing the correlation between the variations of the GMF and the human functional system is increasing but the possible physiological and psychophysiological mechanisms through which these variations interact with different processes in the human organism, have not been clearly established yet. The aim of this paper is to indicate the significance of the relations between GMF changes and various aspects of human functional systems. We have investigated 7 healthy men. The registrations of physiological parameters were made in Faraday cage and out of a Faraday cage. An available press-chamber was used as a Faraday cage. The results confirm the fact that there is a relation between suppression of the variable part of the GMF and the parameters investigated.*

Key Words*: Geomagnetic Field Variability, Physiological Parameters.*

INTRODUCTION

The functional and organic structure of the living organisms is stipulated by a complex of internal biological systems and the physicochemical environment. The variations of this complex are modulated and determined by the solar activity and are provoked by changes in the geosphere and geomagnetic field (GMF) characteristics associated with that solar activity.

The fluctuations in the Earth's magnetic and electromagnetic field play a fundamental role in the living activity of plants, animals and human beings (Brankov, 1995). In the course of their evolution they have accommodated to these fluctuations but they never stop reacting to any sharp, changes occurring under these conditions.

The literature on this subject is scarce and suggests that changes in the normal functioning of the central nervous system, vegetative nervous system, cardiovascular system and cognitive performance may be enhanced by the geophysical variables (Brand and Denis, 1989). Human physiological, psychophysiological and psychical processes as well as sensory abilities may be substantially influenced during periods of significant changes in the GMF determined by Solar-Terrestrial interactions (Maynard, 1995). The interest in revealing the correlation between the geophysical factors and human functional system is increasing (Persinger, 1993 and Ivanova, 1994).

It is possible that the physiological and psychophysiological mechanisms together with the changes in the GMF elements interact with different processes in the human organism, but these results have not been clearly established yet.

The aim of this paper is to indicate the significance of the relations between changes in the GMF parameters and various aspects of the human functional systems. In this sense, various models of reproducing or removing some geophysical effects are quite useful.

In our previous investigations we have used the working environment on board the space station "Mir" to study the physiological aspects of such an environment. We investigated the environment in a decompressed press-chamber (PC), as a model of a partial GMF elimination. In this case the press-chamber was used as a Faraday cage (Fig. 1).

MATERIALS AND METHODS

The registrations were performed out of a PC (under lab conditions) and in a PC. The PC used is constructed

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as a two-layer (10 mm thick each) stainless steel horizontal cylinder, 2.5 m in diameter and 6.5 m long. The PC is hermetic, well-grounded and located in an entirely steel-constructed building of the hyperbaric complex which is also well-grounded. Such conditions are sufficient for the PC to be used as a Faraday cage.

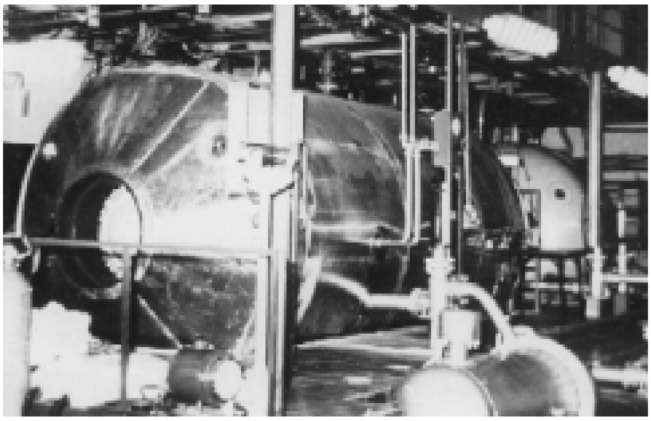


FIG. 1. General view to the press chamber

We registered:

- brain electrical activity - electroencephalograph (EEG);
- brain evoked activity (visual evoked potentials - VET);
- nocturnal sleep (EEG, EKG, electrooculogram-EOG and electromyogram-EMG);
- electrocardiogram (ECG) and R-R intervals;
- blood pressure.

The results obtained were compared to those collected from the same persons under normal conditions (out of PC).

We investigated 7 healthy men free of medicaments and alcohol. Average age - 37,7.

The EEG, ECG, EOG and EMG data were collected via 10 channels recorder Alvar Reega Minidix TR. A simultaneous registration of data on a magnetic tape was made. Racal recorder ST 706 was used.

A visual and digital analysis of EEG registrations was made. The EEG recordings were estimated, using the guidelines of Jermundskaya and Anohin (1984). For the digital analysis we took five consecutive artifact-free epochs, each epoch being of 8 s duration. The common length of the registration was 40 s. We estimated the changes (in %) of the distribution of the activity in 4 frequency gamut - theta θ 3-8 Hz/s.; Alfa (α) 9-14 Hz/s.; beta1(β_1) 15-22 Hz/s.; beta2 (β_2) 23-30 Hz/s. 64 visual evoked brain potentials (single responses) were averaged. The light stimuli (flashes) with approximately 2 s. inter-stimulus intervals were presented with the following stimulus parameters: 0.3J intensity and 0.0002s. duration. Measurements of the amplitude (peak-to-peak) and latency were made of all components (wave from 1 to 7) of VEP.

The sleep stages were visually detected according to the approved classification of Reihtsthafen and Kaless (Rechtschaffen and Kales, 1968) and diagrams of the sleep stages were composed. The number of movements during sleep was calculated. Three groups of movements were determined: movements without disturbances of EEG; movements with disturbances of EEG and only disturbances in EEG.

The digital ECG signal with a step of discretization 512 Hz was processed for digital QRS detection. The length of the R-R intervals was determined and the R-R interval as a function of time was presented by R-R time series. These series were analyzed by means of time domain methods (summary statistics) and by frequency domain methods (power spectrum estimations).

The arterial blood pressure was measured by a standard manometric apparatus 3 or 4 times out and in PC. The average result was calculated for each person.

RESULTS

The subjects investigated were males of average age 37.7, i.e. ranging from 34 to 44 years (Table 1). They had no complaints relevant to sleep and no current medical illness.

Table 1. Arterial blood pressure and age of the subjects investigated.

Name	Arterial blood pressure		Age
	out of PC	into PC	
R.U.	115/80	125/70	37
V.S.	130/80	135/85	38
V.A.	120/78	120/80	39
A.S.	125/80	120/80	35
V.S.	115/75	115/80	44
U.Z.	120/85	130/90	37
V.T.	130/70	135/80	34

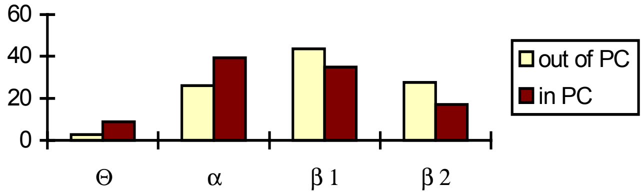
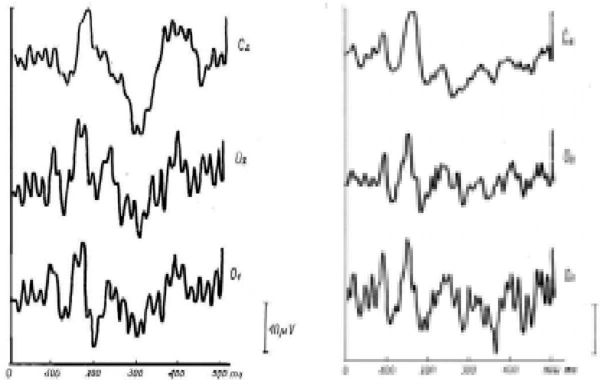


FIG. 2. Spectrum of EEG

The normal organization of the brain electrical activity was established. There were not pathological elements observed in the EEG registrations. The spectral analysis of the EEG activity shows that the slow activity θ and α activity tends to increase under conditions of suppressed variations of the GMT. The fast activity - β_1 and β_2 tends to decrease (Fig. 2).

The amplitude of all VET components tends to decrease in registrations under conditions in PC (Fig. 3).



a) out of PC b) in PC

FIG. 3. Spectra of EEG

There are not clear changes in the latency of the VET components.

Under PC conditions all sleep stages were produced and the sufficient average duration of sleep was recorded. Deep sleep (III+IV stages of sleep) decreases and superficial sleep (I+II stages) increases (Fig .4).

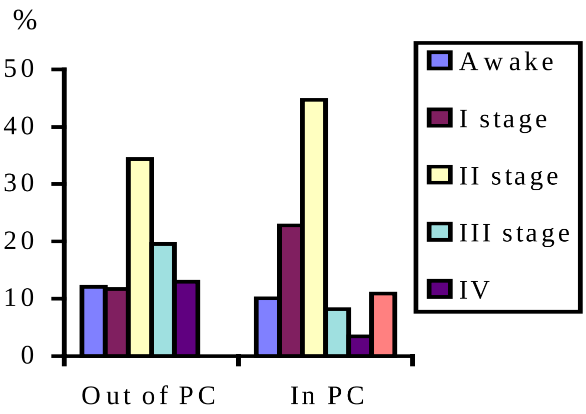


FIG. 4. Stages of sleep

The REM sleep is constant. Often longer (140-165 min) than normal sleep cycles were observed. The number of movements during sleep increases (Fig. 5).

A lack of significant cardiac rhythm disturbances was established. The R-R intervals usually increase under conditions of suppression of the GMF changes as the R-R standard deviation and the R-R variation coefficient tend to be larger (fig.6). The power spectrum of the R-R interval function, obtained by using different algorithms for spectral analysis, shows changes predominantly in the lowest frequency spectral domain in registrations in PC (Fig. 6). In the highest frequency domain a peak is formed in the 0,2-0,4 Hz band which is not registered under normal conditions.

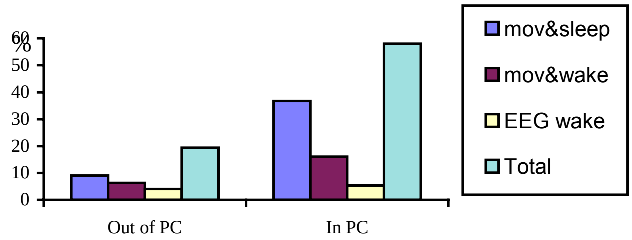


FIG. 5. Number of movement during sleep

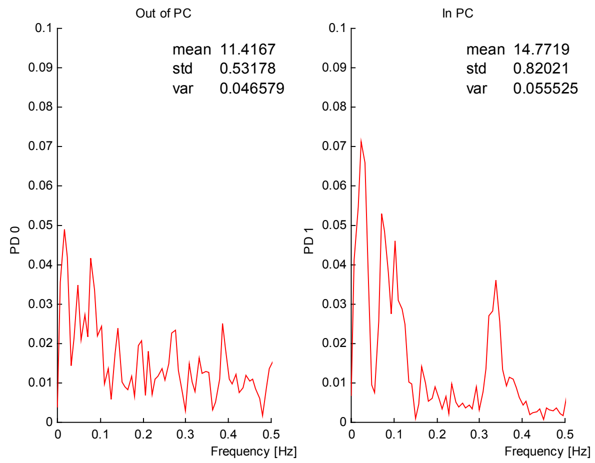


FIG. 6. Representative power spectrums of R-R intervals

The arterial blood pressure tends to be higher in PC than out of PC (Table 1). But the changes are not very demonstrative (122,1/78,2 out of PC and 125,7/80,7 in PC on average).

BRIEF DISCUSSION

Differences between the values of the registered parameters in and out of PC were observed. These results show that the changes in the human physiological parameters produced as a result of the suppressed GMF variations could be monitored and registered. But a full quantitative and qualitative analysis and interpretations are still early to make.

No pathological elements in the EEG were detected at all. Our research confirms that under conditions that suppress the variable part of the GMF human brain produces all normal electrical rhythms - θ, α, β_1 and β_2. However, digital analysis suggests that the slow wave activity in EEG increases in PC. These data with the decreasing amplitude of the visual evoked potentials and the increase in the R-R interval are indicative of a prevalence of the depressive components in the brain regulation and cardiac activity under such conditions. The lack of variation of the GMF toning effect is likely to be the reason for these deviations. The absence of demonstrative changes in the cardiac rhythm shows that these conditions are not a disrhythmogenic factor.

The sleep happens to be more restless under conditions of eliminating the GMF variations. All changes: the increased number of movements during sleep; the decrease in the percentage of slow wave (deep) sleep; the increase in superficial sleep, are a proof of inferior sleep in PC.

No changes were established in the REM phase of sleep, which might be related to the lack of changes in the traditional biorhythms (Evsyukov, 1985).

The tendency of increasing the blood pressure and the changes in the low frequency band of the spectral analysis of the R-R intervals could be related to some deconditioning of the sympathetical regulation. There are changes in the high frequency as well. The power in the 0,2 - 0,4 band is closely related to the vagally mediated respiratory influence over the heart period (Ewing e*t al*., 1991). This influence is accented under PC conditions. The changes in power of all frequencies suggest that there are probably changes in all the components (sympathetic, parasympathetic and humural) that regulate heart activity. Obviously, differences in autonomic control over the heart period exist between the registration in and out of PC.

The human nervous system, like an antenna receives the fluctuations in the geomagnetic field (Mantak, 1988). Man has adapted to the impulses of the GMF fluctuations and their absence stipulates the most likely determined trends of changes in the registered physiological parameters.

The established variations in the physiological parameters in particular have a functional character but they reveal the presence of changes in the fine physiological regulation under the conditions presented.

In conclusion, we studied the influences of the suppression of the GMF variations on some physiological parameters. The results confirm that there is a relation between changes in the GMF and the parameters investigated but the number of registrations is not sufficient to make general conclusions. The results impose the necessity of systematical investigations inthis field. These investigations will contribute to the clarification of physiological and psychophysiological mechanisms through which changes in components of the GMF interact with different processes in the human organism.

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