DETERMINATION OF THRESHOLD OF SENSITIVITY OF THE RABBIT BRAIN TO PULSED SUPERHIGH-FREQUENCY ELECTROMAGNETIC FIELDS

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Investigation of the sensitivity of the rabbit CNS to pulsed superhigh-frequency electromagnetic fields showed that exposure to such a field of intensity $2\,\mu W/cm^2$ for 3 min causes no changes in the EEG whereas exposure to intensities of 250 and $10\,\mu W/cm^2$ leads to the formation of EEG synchronization responses, i.e., to an increase in the number of slow waves and spindles. The results suggest that the threshold of intensity of a pulsed superhigh-frequency field lies between 2 and $10\,\mu W/cm^2$.

The CNS is one of the most sensitive systems of the body to the action of superhigh-frequency (shf) field [3, 7-9]. The character of the changes in its functions, whether demonstrated by the conditioned-reflex [6] or the electroencephalographic [1, 2, 9], depends on the waveband, the power flux density (PFD), the duration of exposure, and other parameters of the shf field [5]. Experiments [1, 2] to assess the sensitivity of the CNS to electromagnetic fields of the shf range, both continuous and pulsed, have shown that the CNS responds to intensities of irradiation lying considerably below the integral heat threshold.

The object of this investigation was to study the responses and establish the threshold of sensitivity of the rabbit CNS to a pulsed shf field by means of an electrographic method.

EXPERMENTAL METHOD

Twenty rabbits were used. Silver wire electrodes were implanted into the cranial bones above the sensomotor and visual areas of the cortex.

TABLE 1. Characteristics of Effects of Pulsed Superhigh-Frequency Field on the Rabbit EEG

PFD of shf field (in $\mu W/cm^2$)	Number of rabbits	Number of exposures	Mean latent period of response (in sec)	Sensomotor area		Visual area	
				character of reaction			
				slow waves	spindles	slow waves	spindles
250	4	318	40,0±5,0	+	+	+	+
10	4	258	52,0±4,0	+	+	+	+
2	6	274	Нет	—	—	—	—
Control	10	244	Нет	—	—	—	—

Legend: +response present (P< 0.01); - response absent (P< 0.05)

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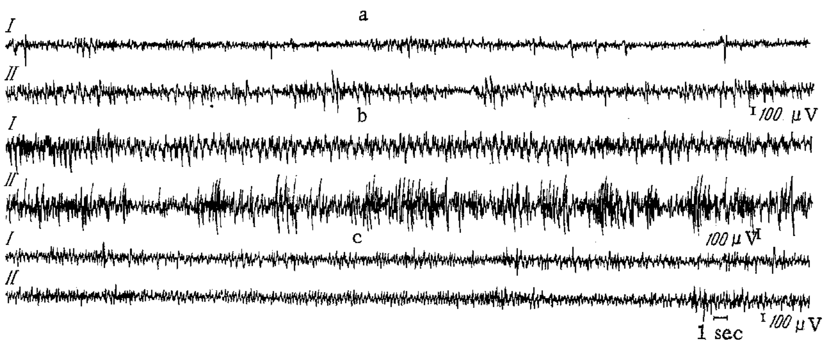

Fig. 1. Changes in EEG of sensomotor cortex of a rabbit during irradiation by shf electromagnetic fields with a PFD of 250 (a), 10 (b), and 2 (c) $\mu W/cm^2$: I) background; II) during irradiation.

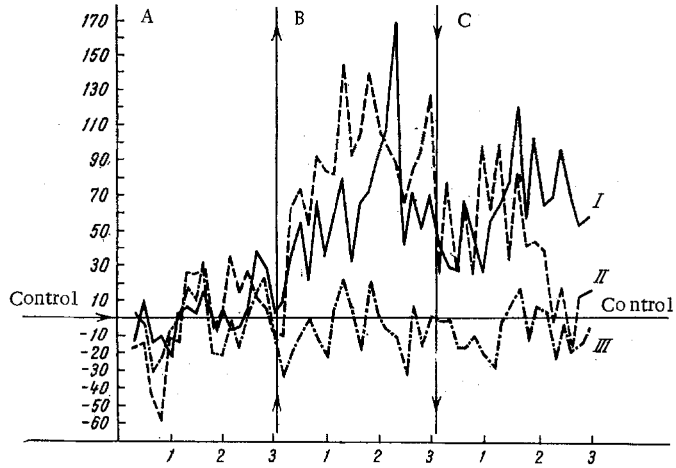

Fig. 2. Relative dynamics of number of slow waves on EEG of sensomotor cortex in rabbits: A) background recording for 3 min; B) exposure for 3 min to shf field with PFD of 250 (I), 10 (II), and 2 (III) $\mu W/cm^2$; C) recording for 3 min after disconnecting generator. Results obtained during "mock irradiation" used as the zero line. Abscissa, time (in min); ordinate, number of slow waves (in %). Arrows indicate generator on and off.

The reference electrode was applied to the nasal bones. Whole-body irradiation was applied to the rabbits from the side opposite to that of the hemisphere from which recordings were made. The EEG was recorded on a 4-channel ink-writing VNIIMIiO electroencephalograph. In experiments on ten rabbits the effects of exposure of the animals to an shf field (wavelength 10 cm) with PFD of 250 $\mu W/cm^2$ (318 exposures, 4 rabbits), 10 $\mu W/cm^2$ (258 exposures, 4 rabbits), and 2 $\mu W/cm^2$ were studied; in the other ten rabbits control records were obtained under identical conditions but without irradiation (244 records).

The background EEG was recorded for 3 min after which, without interruption of the recording, the animal was exposed for 3 min to the shf field; finally the EEG was recorded during 3 min (sometimes 10 min) after the end of the exposure. During the experiment 8-10 exposures were given at intervals of 15-20 min. The number of exposures given to each rabbit was 50-100.

Analysis of the results included counting the number of spindles and slow waves (brain potentials with a frequency of not more than 3 Hz and with an amplitude at least twice that of the mean amplitude of the background EEG) throughout the period of recording the EEG in steps of 10 sec. The difference between the indices in the backgound and experimental periods on summation of over 100 exposures to the shf field was assessed by means of Student's criterion for alternative variability.

EXPERIMENTAL RESULTS

In response to irradiation with the shf field of intensities of 250 and 10 $\mu W/cm^2$ the EEG of all the rabbits studied showed a synchronization reaction (an increase in the number of slow waves and spindles) in both the sensomotor and the visual area of the cortex (Fig. 1), in agreement with results obtained by other workers [1, 2, 4, 9] who used shf fields of higher intensity.

The number of spindles in the EEG of the rabbits, although it increased by a statistically significant amount ($P < 0.01$), did not change so much during exposure to shf fields with PFD of 10 and 250 $\mu W/cm^2$ as number of slow waves. In the subsequent account only changes in the number of slow waves during exposure to the shf field will be discussed.

On summation of the results for all the rabbits in each series of experminets a significant ($P < 0.01$) increase was observed in the number of slow waves during exposure to the shf field with PFD of 250 $\mu W/cm^2$ (for the sensomotor cortex $t = 2.229$) and 10 $\mu W/cm^2$ (for the sensomotor cortex $t = 2.89$, visual $t = 2.45$) over the background level and over the values obtained during irradiation with a PFD of 2 $\mu W/cm^2$ and also during "mock" irradiation (Fig. 2). During irradiation with an shf field of intensity 2 $\mu W/cm^2$ and in the control series none of the rabbits showed an EEG synchronization reaction (Fig. 1). Comparison of the number of slow waves (Fig. 2) in the period of exposure to the shf field of this intensity and in the period when the background EEG was recorded likewise revealed no significant differences.

The mean latent period of the electroencephalographic response showed a tendency to decrease with an increase in the PFD of the shf field (Table 1). Furthermore, during exposure to the shf field with an intensity of 10 $\mu W/cm^2$ the number of slow waves and spindles on the EEG returned to their background values 2-3 min after disconnection of the generator. In the case of exposure to the shf field with PFD of 250 $\mu W/cm^2$ the background indices were restored after 4-5 min. Judging from the latent period of the electroencephalographic response to exposure and the duration of the after-effect, the shf field with higher PFD thus had a more marked effect on the CNS.

The threshold of sensitivity of the rabbit CNS to a pulsed shf electromagnetic field for the developement of analysable electroencephalographic responses was thus evidently between 2 and 10 $\mu W/cm^2$ under the experimental conditions used. It is noteworthy that the threshold of intensity of the shf field for inducing auditory sensations in man during irradiation of the temporal region of the brain is 3 $\mu W/cm^2$ [10].

LITERATURE CITED

1. Z. M. Gvozdikova et al., Byull. Éksperim. Biol. i Med., No. 8, 63 (1964).
2. Z. M. Gvozdikova et al., in: The Biological Action of Radiofrequency Electromagnetic Fields [in Russian], Moscow (1964), p. 20.
3. Z. V. Gordon, Problems in Work Hygiene and the Biological Action of Superhigh-Frequency Electromagnetic Fields [in Russian], Leningrad (1966).
4. Z. V. Gordon et al., in: Work Hygiene and the Biological Action of Radiofrequency Electromagnetic Fields [in Russian], Moscow (1968), p. 39.
5. R. I. Kruglikov, Abstracts of Proceedings of a Conference on Memory Problems [in Russian], Pushchino (1966). p. 33.
6. E. A. Lobanova, in: The Biological Action of Radiofrequency Electromagnetic Fields [in Russian], Moscow (1964), p. 13.
7. A. A. Pan'kin, in: Proceedings of a Conference of Junior Research Workers of the Institute of Work Hygiene and Occupational Diseases, Academy of Medical Sciences of the USSR, Moscow (1969), p. 202.
8. A. S. Presman, Electromagnetic Fields and Living Nature [in Russian], Moscow (1968).
9. Yu. A. Kholodov, Effect of Electromagnetic and Magnetic Fields on the CNS [in Russian], Moscow (1969).
10. A. N. Frey, J. Appl. Physiol., 17, 689 (1962).