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Spike Activity of Supraoptic Cells of Hypothalamus Under 10-day-long Influence of Low-intensity Electromagnetic Radiation

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INTRODUCTION

The CNS has been shown to have the greatest reactivity to the actions of electromagnetic radiation, particularly, to the extremely high frequency electromagnetic radiation (EHF EMR) [Lebedeva, Kotrovskaya, 2001]. The investigations of responses of the hypothalamic structures, such as supraoptic nucleus of hypothalamus (SON), which provide both adaptation to the changes of environmental factors and maintenance of homeostasis of organism at optimal level in conditions of external and internal factors' influences are of great interest. Our investigation was aimed at the revealing of effects of 10 days of exposure low-intensity EHF EMR on the spontaneous spike activity of the rats' SON neurons.

MATERIALS AND METHODS

In acute experiment conditions *in vivo* extracellular recordings were made from cells of SON of hypothalamus in male albino rats. Rats weighing between 250 and 300 g were anaesthetised with Nembutal at a dose of 40 mg/kg I.P. The stereotaxic orientation of electrodes was performed according to Paxinos and Watson' atlas [Paxinos and Watson, 2005]. The localization of the electrode tip in the SON was determined at the end of the experiment by histological control. The animals were subdivided into two groups: control and experimental. As a control (6 rats, 78 neurons) we have used data from intact animals because the parameters of spontaneous activity of SON' neurons of intact and sham-exposed animals were analogously. The impulse activity of supraoptic cells after 10-day-long exposure to the low-intensity EHF EMR was investigated in the experimental group of animals (6 rats, 75 neurons).

Exposure of experimental animal's head was performed daily for an hour. The long axis of the animal's head was parallel to the *E* vector. For irradiation, the animals were not anesthetized. As a source of monochromatic EHF EMR we have used a G4-141 high-frequency generator (Russia). Radiation was performed at room temperature (19-22ºC) at the frequency of 42,2 GHz in a continuous generation regime. Power intensity value at the level of the animal was 0,19 mW/cm^2. The animal's head was exposed in the vertical direction at a distance of 40 cm from the generator horn with an aperture of 30 mm x 30 mm, i.e., in the far-field zone of the horn of pyramidal antenna. Calculated by formula [Gapeev at al., 2008] value for the specific absorption rate (SAR) is received about 1,5 W/kg on the surface of skin of animals head. The analysis of spike activity of registered cells by the distributions of neurons by the degree of regularity, dynamic structure of neuronal streams and different frequency ranges, as well as the mean spike frequency and the coefficient of variation of interspike intervals (ISIs) in naive control and after treatment was carried out. The evaluation of reliability of changes in distributions of ISIs of supraoptic neurons after 10-day-long exposure compared with control was assessed by χ^2 test. Student's *t*-test was made to divulge significant differences in changes of the mean spike frequency and the coefficient of

variation of ISIs.

RESULTS

Analysis of autocorrelograms of stationary supraoptic cells by the grade of regularity has shown a predominance of irregular activity registered in control (79,5%); the amount of cells with intermediate-regularity and non-stationary impulse activity was 11,5% and 9% respectively. “Regular” neurons have not been registered in norm. 10 days of exposure to low-intensity EHF EMR was followed by significant ($p<0,01$) shifts in the distribution of SON’ neurons in terms of the grade of regularity of spike activity. We observed 3,1-fold increase in the quota of neurons with intermediate grade of regularity and 1,5-fold decrease of the proportion of irregular neurons in comparison with the control. The determination of serial correlation coefficients has revealed different types of dynamic structure of current flows. More than half of all recorded in norm impulse flows were characterized by local changes in discharge frequency (56,6%). Among 33,3% of SON’ neurons the train-group activity was observed. Neurons with coincident sequencing of ISIs (2,6%) and monotonic (7,7%) changes in discharge frequency were registered. 10-day-long radiation led to significant ($p<0,01$) shifts in distributions of supraoptic cells by the dynamics of ISIs sequencing. The changes were mainly noted in increase of proportion of units with coincident (3-fold) and monotonic (2,3-fold respectively) changes of sequence of ISIs. The abrupt decrease in quote of neurons with train-group activity (2,8-fold respectively) was observed as well. The coefficient of variation of ISIs and the mean spike frequency of intact animals’ supraoptic cells were respectively 94,6±3,3% and 22,7±1,9 imp/s. The analysis of SON’ neurons distribution by different frequency ranges has shown a prevalence of mid-frequency cells in control (50,7%). The low- and high-frequency units were observed 22,5% and 26,8% respectively. The significant decrease of mean spike frequency to 17,5±1,5 imp/s ($p<0,05$) was observed after the 10-day influence of factor. It was accompanied by appropriate, although non-reliable, changes in distribution neurons by the different frequency ranges. The increase in proportions of low- and mid-frequency cells to 28,9% and 55,1% respectively, as well as decrease in share of high-frequency units to 16,0% were observed. The value of ISIs’ coefficient of variation was changed insignificantly (to 97,7±3,1%).

CONCLUSIONS

Our study has revealed changes in the spike activity of SON' neurons after 10-day-long influence of low-intensity EHF EMR, concerning both of internal structure and of statistic parameters of the registered impulse streams. The 10-day-long influence of EHF EMR led to the changes of neurons excitability which is manifest as the suppression of spike activity of supraoptic neurons.

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