Electrical Activity of the Hypothalamus during Exposure of Biologically Active Points to Millimeter Radiation

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The central nervous system (CNS) is known to be highly sensitive to microwave radiation [3]. The electrophysiological approach to the assessment of the functional state of the CNS has yielded a number of regularities of the effect of millimeter radiation (MMR) on the human and animal brain [1,9]. In view of the fact that exposure of the organism to MMR is especially effective when performed via zones of acupuncture [1], and in view of the important role of the hypothalamus in the mechanisms of acupuncture [14], it is of interest to study the electrical activity of the CNS during the exposure of different acupuncture points to MMR. This makes it possible to assess the general and specific components of the contribution of biologically active points to the central manifestations of the effect of MMR on the organism - the main focus of the present study. Since the physiological effects have been found to depend on the frequency of MMR [1,4], this aspect is also reflected in the present research.

MATERIALS AND METHODS

The experiments were carried out on 9 male rabbits weighing 3-4 kg, in which Nichrome electrodes (0.1 mm in diameter) were chronically implanted in the preoptic zone of the hypothalamus (APL, AP=-4, L=3, H=11 [2]). The indifferent electrode (stainless steel, 0.4 mm in diameter) was placed above the nasal sinuses. The operation (nembutal, 60 mg/kg, i.m.) was performed prior to the experiments. During the postoperative period, the animals were adapted to the experimental conditions; this stage included the recording of baseline parameters (10 min) and the experiment *per se* (2 h).

The electrical activity of the brain was amplified with the aid of an UBPF4-03 amplifier of biopotentials. The frequency spectra of each consecutive 15-sec fragment of the electrograms (EG) were obtained over the 1-30-Hz band (18 subbands) by using a modified method of periodogram analysis [8] on an SM-4 computer. For ease of representation of the frequency subbands, these were assigned rounded-off values of the corresponding midpoint frequencies. Statistical processing of the data and other details of the method were described in the previous publication [11].

MMR was generated with the aid of a G4-142 high-frequency generator and a G6-15 specially shaped signal generator. The latter (by means of sawtooth modulation at a frequency of 1 kHz) enabled us to sweep out each of the 21 radiation frequencies in the range of 55-75 GHz over the band of +0.5 GHz, random 5-min presentations of the frequencies being performed during the ex-

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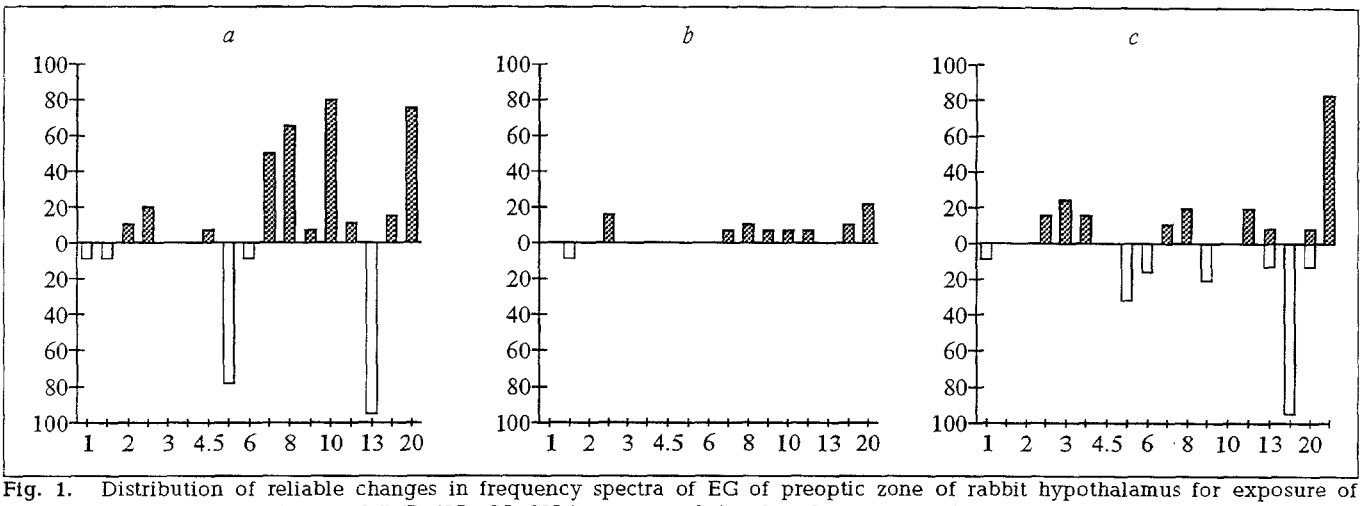

Fig. 1. Distribution of reliable changes in frequency spectra of EG of preoptic zone of rabbit hypothalamus for exposure of different acupuncture points to MMR (55–75 GHz) vs. control (in the absence of radiation) experiments. *a*, *b*, *c*) "heart" (Shin), "longevity" (Zusanli), and "hypothalamus" (Zyaosung) points, respectively. Abscissa: midpoint frequencies corresponding to frequency subbands in EG; ordinate: probability (in %) of occurrence of reliable ($p<0.05$) increase and/or decrease of analyzed rhythms (bars up and down, respectively).

periment. Later, the data were averaged over the corresponding 5-min intervals. Radiation (10 mW) was aimed at the zones to be exposed via a flexible polyethylene waveguide (70 cm) with a 2.2×4.4 mm section area (the tip was positioned 1.5-2 cm from the surface of the skin). Three left zones comprising the points Shin, Zusanli and Zyaosung [7], corresponding to auricular ("heart"), corporal ("longevity"), and cranial ("hypothalamus") points, respectively [13], were chosen for bombardment. In each of the three groups comprising 3 rabbits, just one of the points studied was irradiated during the experiment. One day prior to the experiment the parameters in question were recorded in a sham experiment in the absence of irradiation. Later, such a scheme was reproduced in each group of animals for other zones, the sequence of irradiation of the points being different in different groups. After the series of experiments was finished, the location of the tips of the electrodes was monitored in the brain.

RESULTS

Analysis of reliable ($p<0.05$) MMR-induced changes in the EG spectra of the hypothalamus showed marked differences in both the intensity of the responses and their qualitative pattern, depending on which of the responsive zones was exposed to radiation. For example, with respect to the EG spectra, the effectiveness of exposure of the "heart" point to radiation proved to be higher than that in the case of the "hypothalamus" point and all the more so than that for the "longevity" point, this being manifested as reliable differences (according to the *U* test) of the probabilities of occurrence of the above changes in the EG (31, 21, and 5%, respectively). At the same time, irradiation of the

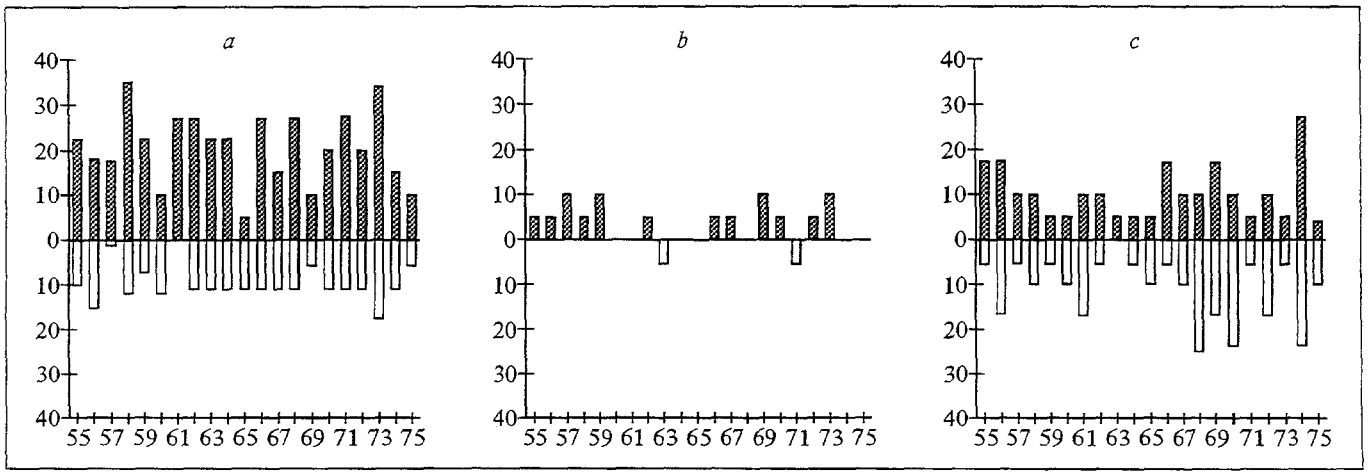

Fig. 2. Effects in spectrograms of preoptic zone of hypothalamus as a function of frequency of MMR for exposure of different acupuncture points to radiation. Abscissa: frequency of MMR, GHz. Other notation as in Fig. 1.

auricular ("heart") point (Fig. 1, *a*) was mainly attended by suppression of the rhythms at 5 and 16 Hz and by their enhancement at 7-8, 12, and 26 Hz, whereas a virtual absence of any pronounced responses is typical of the "longevity" point (Fig. 1, *b*). Irradiation of the "hypothalamus" point (Fig. 1, *c*) caused changes in the electrical activity of this zone that were qualitatively similar to the results for the "heart" point. Quantitatively, differences manifested themselves as a lower intensity of the effects at frequencies of 7-8 and 12 Hz in the experiments involving the "hypothalamus" point. When the intensity of the effects was considered as a function of the frequency of MR (Fig. 2), no marked "resonance" changes were discovered. An exception was the response of the hypothalamus to irradiation of the "hypothalamus" point at a frequency of 74 GHz (Fig. 2, *c*), which occurred with a higher probability (50%) as compared to the effect caused by irradiation at other frequencies.

The findings may be regarded as additional experimental evidence that, in contrast to the corporal points, the exposure of auricular points to radiation leads to a heavier involvement of different brain structures [6]. On the other hand, the quantitative data on the probabilities of occurrence of reliable changes in the EG for irradiation of the "heart" and "longevity" points (31 and 5%, respectively) specifically correlate with the empirically chosen ratio between the times of exposure of the auricular and corporal points (1:5) under the conditions of laser acupuncture [5]. Nevertheless, in the present study "resonance" frequencies [1,4] were not shown to play any appreciable role. This was possibly due to the prolonged (5 min) averaging, because a rapid appearance and completion of the effects are characteristic of the hypothalamus for the use of MMR [1]. The data on individual and typological specificities of the responses to this radiation [4], in particular, in the EG of the brain [9], as well as the conclusions that the dependence of the effects on the MMR frequency is smoothed out as the regulatory mechanisms of the system become more complex [10] and that the CNS helps initiate the mechanism of the effect of acupuncture [12], prove that more local electrical patterns of the brain have to be analyzed in order to discover the "resonance" processes.

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