Immunomodulating Effect of Weak Magnetic Fields on Antibody Production in Mice

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The possibility of a resonance mechanism of immunomodulation of antibody secretion by immune antibody-producing splenocytes in mice is demonstrated. Parameters of the effects of weak magnetic fields on the process of immune antibody production in mice are defined.

Key Words: *weak magnetic fields; antibody secretion; mice*

Many facts are now available indicating marked sensitivity of the body and of individual cells, cell organelles, and protein enzymes to magnetic fields lower than the earth's level, to weak electromagnetic radiation, light exposure, weak direct and alternating currents, and to low homeopathic doses of chemical compounds [2,3,6,7]. Besides being interesting from a theoretical viewpoint, these data open up new vistas for therapeutic exposures to various fields and currents of low, in principle safe, intensities. The mechanisms of such processes are still unclear. We proposed that low-intensity exposures acquire the pattern of a signal, so that there is an information type effect on the organism. The mechanism of resonance - enhancement of certain parameters of a system during exposure to strictly defined signals - is one of the best known and best studied mechanisms of such exposures.

The purpose of our study was to elucidate the possibility of a narrow-resonance exposure of a biological object to low-intensity factors as exemplified by the process of antibody secretion by immune antibody-producing cells (APC) in mice.

MATERIALS AND METHODS

BALB/c mice weighing 17-19 g from the Stolbovaya breeding center of the Russian Academy of Medical Sciences were used. For immunization red cells from 2-3 outbred rats were taken; the cells were washed in Hanks solution three times, and 0.5 ml of the suspension was injected intraperitoneally in a dose of 5 mln cells per mouse. Exposure to magnetic fields (MF) was carried out with a specially designed device permitting the creation within a 5-7 cm radius of a strictly dosed (accuracy 2%) permanent MF of 0-2 Gs strength and an alternating MF of 1-100 Hz frequency and 0-2 Gs strength in the vertical direction. The MF horizontal constituent was compensated for with an accuracy of up to 5% by permanent magnets. Splenocytes from 3-5 mice on sensitization days 3, 4, and 5 suspended in Hanks solution with glucose were mixed in the same tube and poured into several tubes, 0.5 ml containing 5 mln cells into each tube, and then exposed for various periods to a permanent or alternating MF. Then samples from each tube were tested in three variants for intensity of secretion of antibodies to specific antigens by the plaque method in a monolayer in glass chambers [5]. For this purpose washed splenocytes of immunized mice (0.5 to 1 mln cells in 0.05 ml Hanks solution) were mixed with a similar volume of 1% red cells with which the animals were immunized and with 0.05 ml of 1:6 diluted rabbit complement adsorbed with rat red cells. The chambers were covered with cover slips and put into an incubator at 37°C in an exsiccator where 100% humidity was created. After 24 h

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hemolytic plaques in the chamber were counted, their number indicating the count of active APC, which was expressed in absolute values per mln splenocytes of immunized mice.

The effects of MF were compared by the absolute APC counts and by the estimated stimulation index (ratio of APC in the experiment and in the control without stimulation in %).

RESULTS

The immune response of mice to rat red cells increased when the antigen was used in tested doses 0.1 to 10 mln per animal and reached its peak 4 days after immunization, and therefore in subsequent experiments we used the dose 1 mln red cells and the period 4 days postimmunization.

A study of the effect of a permanent MF on APC secretion of antibodies to specific antigen revealed a marked reduction of secretion after an exposure as short as 2 min in a permanent MF of 0.2-2 Gs intensity. When the exposure was prolonged to 4 min, the degree of suppression of the effect was more pronounced and was maximal for the said conditions at a level of 0.5 Gs; a further increase of intensity lead to the appearance of a stimulating effect observed with the maximal values of field intensity tested (Fig. 1).

Scanning of the frequency domain in the 10-50 Hz band through every 1 Hz during a 4-min exposure to a permanent MF of 0.2-1.0 Gs showed 30-40% stimulation of the visible APC count for 21 Hz frequency. Examination of the 20-22 Hz band through every 0.1 Hz showed narrow-resonance peak of stimulation at frequency 21.1 Hz (Fig. 2). A 0.1 Hz shift of frequency reduced stimulation efficacy several times.

The effect of APC stimulation with an alternating MF of a strictly definite frequency and high values of a permanent MF during the suppressive effect of low MF doses compatible with the geomagnetic field intensity was reproduced in the overwhelming majority of experiments on days 3, 4, and 5 after animal sensitization was started (altogether 17 observations in several independent series in various seasons of the year), although the intensity of the field effect varied from 45 to 635%. The experimental method per se yielded in this case negligible (no more than several percent) absolute differences in APC counts, this making the revealed effects highly reliable ($p<0.001$ in the large majority of cases).

Hence, it was possible to attain a manifest regulatory effect on the process of APC secretion of antibodies to specific antigen in mice, which was expressed by changes in the visible cell count

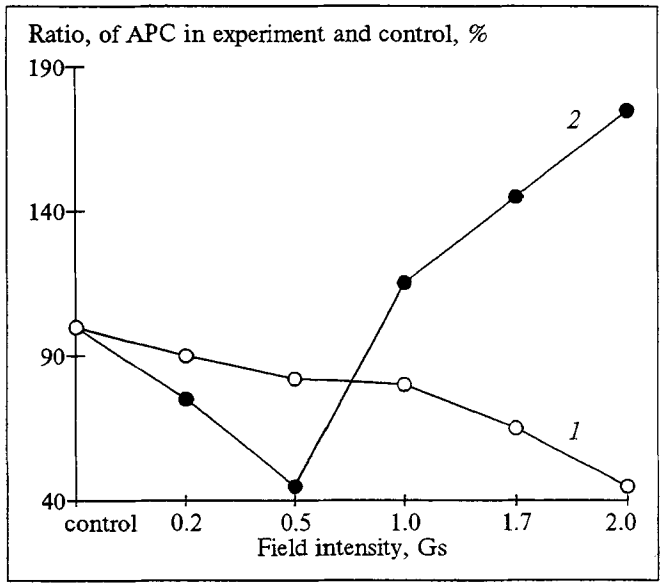

Fig. 1. Relationships between permanent MF immunomodulation of antibody secretion by APC, field intensity, and exposure duration. *1*) 2-min exposure; *2*) 4-min exposure. Presented are mean values and findings of a typical experiment; triplicate tests were carried out.

and was evidently determined by the number of active and inactive APC.

A narrow range of exposure parameters is characteristic of the "resonance" mechanisms of the effects of physical factors on systems of different types. There is no lower threshold exposure in principle for a resonance type of exposure and even the minimal signals matching the optimal reaction domain markedly enhance this or that characteristic or

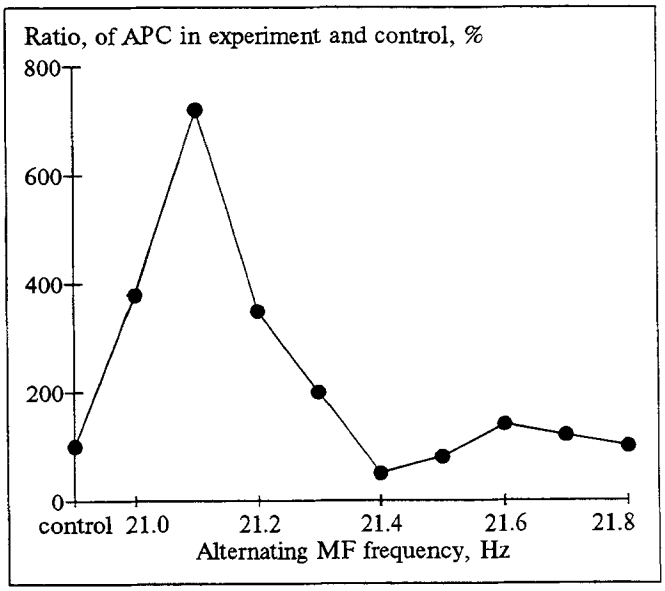

Fig. 2. Relationship between alternating MF immunomodulation of antibody secretion by APC and field frequency. Exposure duration 4 min, field intensity 1 Gs, day 4 of animal sensitization. Presented are mean values and findings of a typical experiment; the tests were in triplicate.

function of a system [1,4]. Such a mechanism may in fact underlie the action of many low-intensity factors, particularly physical ones, determining their manifest influence on biological systems.

The specific nature of resonance structures of the body may be very different: mechanisms of electron and ion transport underlie virtually all the processes of production and utilization of energy, metabolism regulation, and different intricate physiological functions. The most important of these are regulatory rhythms of the brain, local processes of organic self-regulation, as well as intracellular rhythmic processes of intercoordinated activity of organelles and, above all, processes involving membrane structures which determine electrical and chemical gradients, ion transport, etc.

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Comparative Study of Transport of Exogenous Radioactive Histone Administered by Various Routes

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Accumulation of radioactive label in olfactory bulbs is found to outstrip the label content in the blood of animals to which histone is administered intranasally. The concentration of the label in the blood is highest after intraperitoneal injection, but shortly afterwards radioactive histone is detected in the brain as well.

Key Words: *radioactive histone; various routes of administration; accumulation in the blood and brain*

The intranasal route of drug delivery is becoming more and more popular of late, particularly when it concerns a certain class of pharmacological compounds. This applies first of all to peptides, among which many substances have been found to be useful for the treatment of many serious diseases, including diseases of the central nervous system (CNS). The possibility of such dosage forms and their sufficient efficacy necessitate a detailed study of this route of drug administration in order to better validate it and use it on a wider scale, with other drugs of peptide and nonpeptide nature as well.

In the present research we compared the penetration of peptides or small proteins into the CNS after intranasal and intraperitoneal adminis-

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