RECENT ADVANCES IN STUDY

ON MOBILE PHONE EXPOSURE TO THE BRAIN OF THE RAT

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ABSTRACT

Mobile phones have come into wide use in recent years. Social concerns have been raised about their effects on brain tissue such as the blood-brain barrier (BBB), nerve cells, etc. and brain functions such as memory system, sleep rhythm, etc. because the antenna of mobile phones is located next to the user's head. We will report our recent results in these matters.

INTRODUCTION

The close proximity of cellular phones to the human head and the absorption of some of the radiated energy into the head have raised social concerns about the effects of exposure to EMW on the permeability of the blood-brain barrier (BBB), behavior and cognitive functions, and a sleep-related hormone. The exposure to high-intensity EMW in the UHF range produces heat and can cause thermal damage to the brain. However, the effects of exposure to sufficiently low-intensity EMW, that does not cause elevation of brain temperature, are yet to be clarified.

MATERIALS AND METHODS

The exposure system and the calculation of the Specific Absorption Rate (SAR) were described by Watanabe et al [1]. This system consisted of a small anechoic chamber and a round turntable with eight tubes mounted circularly. Unanesthetized male Sprague-Dawley (SD) rats were restrained in the tubes with their heads positioned toward the central antenna. The frequency of the microwave field was 1,439 MHz based on the PDC standard, that is the main frequency of mobile telephones in Japan.

To evaluate the biological effects of the EMW exposure to the brain, the permeability of the BBB, the morphological changes of the brain and the changes of body mass, were investigated. The SD rats were divided into three groups consisting of twelve rats each, EM (+), EM (-), and control groups. The EM (+) group was exposed to microwaves in the above stated condition. EM (-) group, i.e., without microwave exposure, was also placed in the same condition as the EM (+) group. The control group was not placed in tubes nor exposed to microwaves. The effects of the microwaves at two different average SARs of the brain, 0.99 W/kg and 7.4 W/kg, were investigated. Rats were exposed to either 0.99 W/kg for one hour/day for two or four weeks or to 7.4 W/kg once for four hours [2].

For the T-maze tests, the rats were food deprived to 75-80% of their normal body weight and received one daily feeding of measured amounts of food to restrict weight increase for the behavioral tests. Behavioral evaluations were carried out in a T-maze made of clear Plexiglas. The dimensions of both arms and the stem of the T-maze were 90 cm x 15 cm x 15 cm. The starting box (20 x 20 x 20 cm) was separated from the stem by a manually operated guillotine door. One food cup (1.5 cm deep) was located at the end of each choice arm. Rats were transferred from the maze through the hinged doors that were fixed at the end of each arm. Animals had access to a variety of extramaze cues surrounding the test apparatus. The number of correct choice in each rat was recorded.

With respect to effects of microwave on sleep, the melatonin concentrations in the pineal body and blood were measured by radioimmunoassay (See 1543 for the detailed methods).

RESULTS

In rats exposed to EMWs for 2 weeks, no change in the permeability of BBB was observed in any of the groups (EM (+), EM (-), and control) by the Evans blue injection method, nor by immunohistochemistry for albumin. Also in rats exposed to EMWs for 4 weeks, no change in the permeability of BBB was found. The morphological change of the cerebellums was investigated by determining the degeneration of Purkinje cells and the cell concentration in the granular layer. No significant changes were observed in any of the groups after microwave exposure during either the 2-week or 4-week exposure series. Body mass was also not affected by EMW exposure.

The memory system was tested with a T-maze. No remarkable difference in transition of the number of correct choices was found among exposure (the average brain SAR of 7.4 W/kg), sham control and cage control groups. The body temperature did not change in exposure (7.4 W/kg), sham control and cage control groups.

The pineal melatonin level per body weight had a tendency to decrease with short-term TDMA exposure, although the difference was not statistically significant (P=0.11). On the other hand, the pineal melatonin level and the serum melatonin level were unchanged.

DISCUSSION

Recently there has been much inquiry and apprehension about the possible development of brain tumors by exposure to cellular phones. One of the possible mechanisms for tumor development is the increase in the permeability of the BBB, which may result in the entry of carcinogenic substances into the brain. These harmful substances may also cause epilepsy by disrupting the cellular balance. Therefore, we investigated effects of brain exposure to working (real-world) levels EMW, especially focusing on changes in the permeability of the BBB.

To investigate the degree of stress induced in rats by their confinement in the narrow tubes and/or by exposure to the high-frequency EMW, changes in body mass were evaluated during the experimental period. The body masses of the rats in EM (+) and EM (-) groups did not differ from those in control group for either period. Thus, neither exposure to microwaves nor confinement in the tubes is a stimulus stressful enough to alter the body mass of rats.

The simplicity of a T-maze made it ideal for the present study because few other factors like strength or motor activity of each rat could have affected the results. In addition, T-maze reversal learning is a reliable method for the assessment of learning and memory functions. Numerous studies have used the same procedure and the memory systems involved

in the reversal task as well as the spatial discrimination task have been well investigated.
In conclusion, a 1,439-MHz TDMA field used in cellular phones in Japan, at energy levels commensurate with cellular-phone use, did not induce observable changes in either the permeability of the BBB, or morphological changes in the cerebellums, or body mass changes, as evaluated by the conventional.
The exposure at levels much stronger than emitted by cellular phones did not affect the learning and memory processes of rats when the exposure did not cause thermal effects.
Short-term TDMA exposure may slightly inhibit pineal melatonin synthesis, but no significant effects were observed in this limited experimental setting.

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