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Effects of 900 MHz electromagnetic field on TSH and thyroid hormones in rats

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Abstract

In this study, the effects of exposure to a 900 megahertz (MHz) electromagnetic field (EMF) on serum thyroid stimulating hormone (TSH) and triiodothronine–thyroxin (T_3–T_4) hormones levels of adult male Sprague–Dawley rats were studied. Thirty rats were used in three independent groups, 10 of which were control (without stress and EMF), 10 of which were exposed to 900 MHz EMF and 10 of which were sham-exposed. The exposures were performed 30 min/day, for 5 days/week for 4 weeks to 900 MHz EMF. Sham-exposed animals were kept under the same environmental conditions as the study groups except with no EMF exposure. The concentration of TSH and T_3–T_4 hormones in the rat serum was measured by using an immunoradiometric assay (IRMA) method for TSH and a radio-immunoassay (RIA) method for T_3 and T_4 hormones. TSH values and T_3–T_4 at the 900 MHz EMF group were significantly lower than the sham-exposed group ($p < 0.01$). There were no statistically significant differences in serum TSH values and T_3–T_4 hormone concentrations between the control and the sham-exposed group ($p > 0.05$). These results indicate that 900 MHz EMF emitted by cellular telephones decrease serum TSH and T_3–T_4 levels.

Keywords: 900 MHz electromagnetic field; TSH; T_3; T_4

1. Introduction

Biological effects of electromagnetic field (EMF) and their consequences on human health are receiving increasing scientific interest and has become the subject of great public debate. The controversy has been stimulated by some epidemiologic studies that have re-

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ported a relation between magnetic field exposure and human diseases (Selmaoui et al., 1997).

Such has been the rapid growth of mobile telecommunications that there will be about 1 billion mobile phone users before 2005. Herein, if there is any impact of mobile telephones on health, it would affect almost everyone in the world (Repacholi, 2001).

At the present, most of the mobile phones in Europe generally work at a frequency of 900 MHz in the GSM systems. The cellular responses to various forms of radiation, including ionizing, UV-radiation or exposure to electromagnetic fields are manifested as reversible or irreversible from structural to functional changes (Rothman et al., 1996; Somosy, 2000; Cox, 2003). Over the past two decades, there has been increasing interest in the biological effects and possible health outcomes of the weak, high-frequency electric and magnetic fields (Knave, 2001). Some studies on the magnetic fields and cancer, reproduction and neurobehavioral reactions have presented that different system diseases are related to the electromagnetic fields such as those similar to ones produced by mobile phones (Cox, 2003; Knave, 2001; Leszczynski et al., 2002; Bartsch et al., 2002; Bortkiewicz, 2001).

Thyroid activity is regulated by the thyroid stimulating hormone (TSH) secreted by pituitary. Elevated TSH levels induce the thyroid to elaborate triiodothronine (T_3) and thyroxin (T_4), a hormone which functions in at least 20 enzyme systems; one of its major influences involves the acceleration of protein synthesis.

Animal studies have shown that exposure to radiofrequency electromagnetic fields may alter the endocrine or the nervous systems and especially the thyrotropin secretion (Lu et al., 1981, 1985, 1987; Michaelson, 1983; Lai et al., 1987, 1989; Lai, 1992).

The aim of this study was to investigate whether the serum TSH and T_3–T_4 hormone levels of adult male Sprague–Dawley rats could be altered after exposure to the 900 MHz GSM-like EMF generator.

2. Material and methods

2.1. Study protocol

The animals used in this study were proceed, maintained and used in accordance with the Animal Welfare Act and the Guide for the Care and Use of Laboratory Animals prepared by the Suleyman Demirel University, Animal Ethical Committee. Twenty male Spraque–Dawley rats (12 weeks old, each weighing between 250 and 300 g at the start of experiment) were maintained under a 12-h light/12-h dark cycle in a temperature-regulated ($23 \pm 1\,^{\circ}C$) animal room with a continuous free access to water and food. Animals were randomly grouped as follows: control group (without stress and EMF) ($n = 10$), sham-exposed group ($n = 10$) and a 900 MHz EMF ($n = 10$). The 900 MHz EMF group was exposed to 30 min/day radiation for a period of 5 days/week. The EMF exposure period was at 10:00–11:00 a.m. in each day and lasted for 4 weeks. Sham-exposed group stayed in the experimental setup with the same conditions as the exposure groups without radiation exposure (exposure device off). Rats that were exposed to the 900 MHz EMF were compared to control rats in respect to the serum TSH and T_3–T_4. At the end of 4 weeks, the rats were sacrificed and blood samples were collected through a cardiac puncture.

2.2. Experimental setup and radio-frequency irradiation

A special exposure device with five exposure antenna was used. The Fig. 1 shows one of the antennas of the device. The exposure system consisted of a round plastic tube cage (length: 12 cm and diameter: 5.5 cm) and a dipole antenna. The whole body of the rats was positioned in close contact above the dipole antenna, and the tube was ventilated from head to tail in order to decrease the stress of the rat while in the tube. The 900 megahertz (MHz) continuous wave electromagnetic energy generator (the peak specific absorption rate, SAR, was 2 W/kg, average power density $1 \pm 04\,mW/cm^2$) produced at the electromagnetic compatibility (EMC) Laboratory of Suleyman Demirel University was used in the study. The power density measurements were made using electromagnetic field meter (Holaday Industry Inc., Adapazari, Turkey).

2.3. Serum hormone radio-immunoassay

Blood samples were collected into the glass tubes without anticoagulant and were allowed to clot. It was centrifuged to obtain serum and stored at $-20\,^{\circ}C$ until the assay. Serum TSH hormone levels were measured using TSH IRMA kit and total T_3–total T_4 hormone