EFFECT OF MOBILE PHONES ON TRACE ELEMENTS CONTENT IN RAT TEETH

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ABSTRACT

Widespread use of wireless communication made it necessary to investigate the long term effect of mobile phone, which is the most popular technological equipment in the earth. One of the important parts of body that absorbs radiation emitted from mobile phones is oral tissue. However, mobile phone users and also scientists usually do not pay attention on effect of mobile phone exposure on oral tissue. Therefore, there is no epidemiological and experimental studies focused on this part of body. The aim of this study was to investigate the effect of GSM (Global System for Mobile Communication) -Modulated 900 MHz radiofrequency radiation on trace element content of rat teeth. Thirty one Wistar Albino adult male rats were divided into three groups: experimental group (each, n=14), shame group (n=7), and cage control group (n=10). Head of the rats in the experimental group were exposed to GSM-Modulated 900 MHz radiofrequency radiation for 2 hours per day during ten months. At the end of the exposure period, the contents of some trace elements as Ca, Mg, Zn, and P were measured in the oral tissue. The measurements were performed by Atomic Absorption Spectrophotometry (AAS). However, phosphorus content of teeth was measured by ultraviolet spectrophotometer (UVS).

Changes of Mg, and Zn contents in the experimental group were found to be statistically significant according to the sham and cage control groups. Ca and P contents in the experimental group were higher than the sham and cage control groups. Difference between the groups was not statistically significant ($p>0.05$). The results of the study showed that GSM-Modulated 900 MHz radiofrequency radiation can be a factor to alter the teeth trace elements' densities. However, further studies are necessary to know whether GSM-Modulated 900 MHz radiofrequency radiations affects the oral tissues such as the teeth.

Keywords: GSM, 900 MHz, radiofrequency radiation, teeth, trace elements

Introduction

Over the past two decades, mobile telecommunication system has been widely used all over the world. The use of the mobile telecommunication system has been rapidly increased. Widespread concerns have been raised about the possibility that exposure to the radiofrequency (RF) fields from mobile telephones or their base stations could affect people's health. Such has been the rapid growth of mobile telecommunications that there will be about one billion mobile phone users before 2005 (20). It is unclear whether exposure to the fields generated by these devices is linked with health effects. Some epidemiological studies investigations indicate that cellular telephone exposures may be associated with elevated brain or ocular cancer risks (12).

Although there is a vast body of material on the biological effects of radiofrequency fields, current risk assessment is still limited. There are several hypotheses and results of biological effects such as thermal effect, genetic and carcinogenic effects and cancer related investigations (13).

Oral tissues are one of the important parts of head/body that absorbs the radiation emitted from mobile phones; however, scientists did not take into consideration this field. Therefore, our goal is to investigate the effect of radiation emitted from GSM on teeth trace element contents.

Trace elements play an important and complex role in the human and animal metabolism (2). Rat teeth have been used as indicators of exposure to several trace elements. The trace elements in teeth have been examined for a number of reasons, for example there are some studies of dental health where trace element contents have been correlated with the presence of dental caries (2). The mineral tissue of the tooth consists of hydroxyapatite crystals $Ca_{10}(PO_4)_6(OH)_2$ with incorporated trace elements, which can provide information of the habitat environment or dietary habits (2). The importance of measuring trace elements in teeth was also motivated due to their importance as bio-indicators, connecting the deposited chemical elements in the tooth to the environment and/or dietary habits, and with the promotion or inhibition of teeth cavities (1, 11, 17, 19, 23). However, very little is known regarding the GSM-Modulated 900 MHz radiofrequency radiation influence on electrolyte balance and contents of some trace elements in teeth, and there are no studies that quantify the changes of

Ca, Mg, Zn and P in rat's teeth, which are treated with mobile phones and radiofrequency.

In this study, we investigated long term effect of radiation emitted from mobile phones on some trace element contents of rat teeth.

Materials and Methods

Subjects and Animal Care

Thirty one Wistar Albino adult male rats with initial average weight of 267±15 g were obtained from the Medical Science Application and Research Center of Dicle University (Diyarbakır, TR), caged individually, and fed with standard pelletted food (TAVAS Inc. Adana, TR). Final average weight of the animals was 363±18 g. They were separated into three groups – cage control (n = 10), sham exposed (n = 7) and experimental (n = 14), and kept on a 14/10 hour light/dark schedule. During the study, the ambient temperature (22°C) and relative humidity (45%) were maintained in the normal range for these animals. All animal procedures were in agreement with the Principles of Laboratory Animal Care and the rules of Scientific and Ethics Committee of Dicle University Health Research Center.

Exposure and measurement of radiation

A generator (GSM Simulator 900PM10 type Everest Comp., Adapazarı, Turkey), which produces 900 MHz radiofrequency radiation was used in this study to represent exposure of global systems for mobile communication (GSM). Emitted power (circular space distribution) of the generator was fixed at 2 W during exposure. Antenna of the generator was equivalent to the antenna of mobile phones.

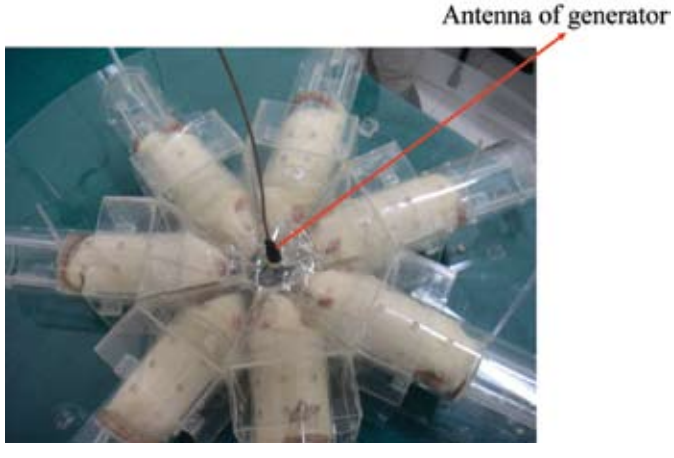

Fig. 1. Exposure System

The rats were confined in a Plexiglas carousel, and rat heads in the carousel exposed to 900 MHz microwave exposure emitted from generator (**Fig. 1, Fig. 2**). For the study group, rats exposed to the radiation 2 hours per day (7 days in a week) for 10 months. For the sham group, rats were placed into the carousel and same procedure was applied to the rats (2 hours / day / 7 days in a week for 10 months), meanwhile, the generator was turned off. Antenna of the generator was placed at the center of a Plexiglas carousel to provide ideal exposure (**Fig. 1**). Distance between antenna and the head of the rats was 1.5 cm. Power Density inside Plexiglas carousel cages was measured by EMR 300 (NARDA, Pfullingen, Germany). Average power density at the center of the carousel cages was measured as 0.0252 mW / cm^2. However, average power density at the area of rat tails was measured as 0.0045 mW / cm^2. The rats were free to move in a methacrylate cage inside the coils. Immediately after the last exposure, teeth of the animals were collected under ketamine anesthesia (100 mg/kg, intramuscularly) in sterile saline to measure the levels of trace elements.

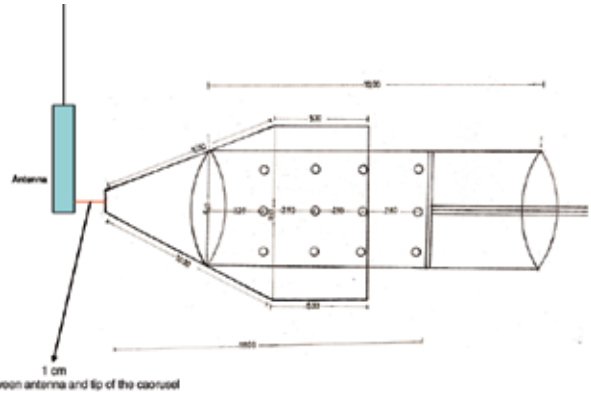

Fig. 2. Details of exposure cage

The measurement of trace element contents in teeth

The teeth were placed in a high form porcelain crucible. The furnace temperature was slowly increased from room temperature to 500 °C in 1 h. The samples were ashed for about 4 h until a white or grey ash residue was obtained. The residue was dissolved in 3 ml of the mixture of the 65% nitric acid (HNO_3), 30% hydrogen peroxide (H_2O_2) (3:1), when necessary, was heated slowly to dissolve the residue. The solution was transferred to a 10 ml volumetric flask and made up to the volume. The calcium (Ca), magnesium (Mg) and zinc (Zn) content of teeth was determined by atomic absorpsion spectroscopy (AAS) and phosphorus (P) content of teeth – by ultraviolet spectrophotometry (UV).

Statistical Analysis

A computer program (SPSS 10 SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Data were analyzed by Kruskal-Wallis One-way analysis of variance (ANOVA) on ranks and post hoc multiple comparison tests using Dunnet's procedure. All hypothesis tests used a criterion level of $\alpha = 0.05$.

Results and Discussion

The concentration of Ca and P in the rats' teeth of the experimental group were found to be higher than sham and cage control groups, but the results were not statistically significant ($p>0.05$), (**Figs. 3, 5**). Zn and Mg concentration in teeth of experimental group were significantly different from both sham and cage control groups ($p<0.05$) (**Figs. 4, 6**).

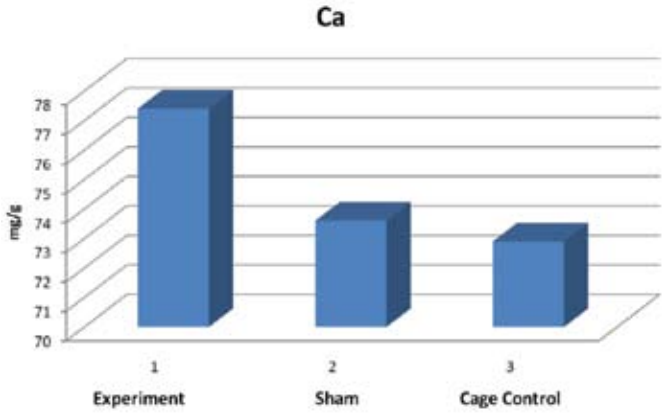

Fig. 3. Differentiation of Ca among groups

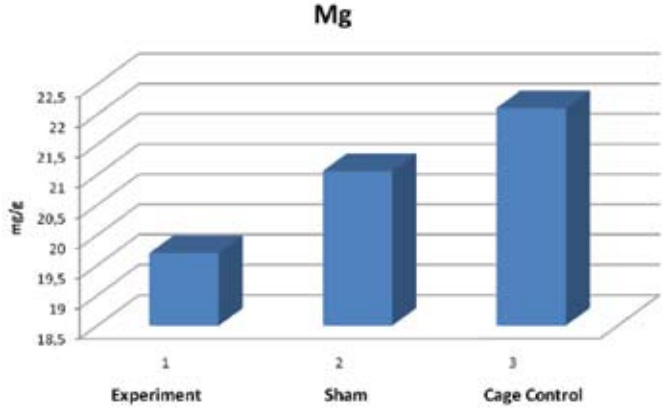

Fig. 4. Differentiation of Mg among groups

The rise of Zn content and the decline of Mg concentration in the experimental group showed that the radiofrequency used in this study (900 MHz) affected the teeth trace element content. The alteration in these two trace elements can be due to stress. Because, most of the studies stated that microwave/ radiofrequencies are a stressor factor on biological systems.

Teeth, both animal and human are often used as bio-indicator for environmental pollution (3, 5, 6, 7, 20, 24). The trace elements in teeth play an important role for dental health since the trace element concentrations are correlated with the presence of dental caries, proper human functioning, to control enzymatic processes (2, 10, 15).

The diversified GSM-Modulated 900 MHz radiofrequency radiation exposure of group was reflected by the concentrations of the trace elements (Ca, Mg, P, Zn) in teeth.

The differences were distinct, especially for Mg and Zn. Hence, increased concentrations may cause different effects such as high caries risk in tooth.

The direct comparison of results from this work with previous studies is complex because of the lack of studies in this area. However, some useful comparisons can be made with sham and cage control groups. This was not detrimental to this research, as the primary aim was to compare the trace element content of teeth from experimental and sham, cage control groups.

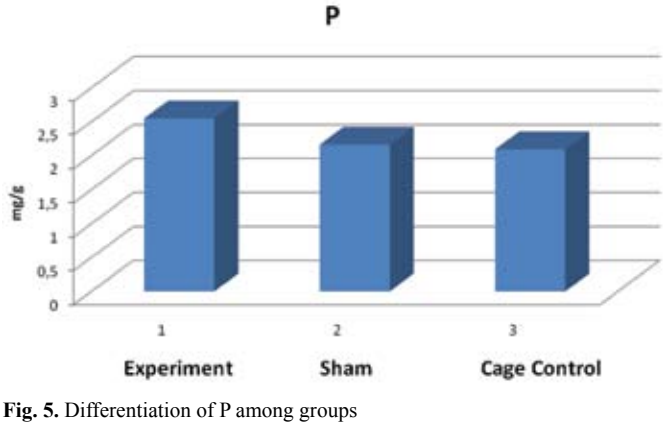

Fig. 5. Differentiation of P among groups

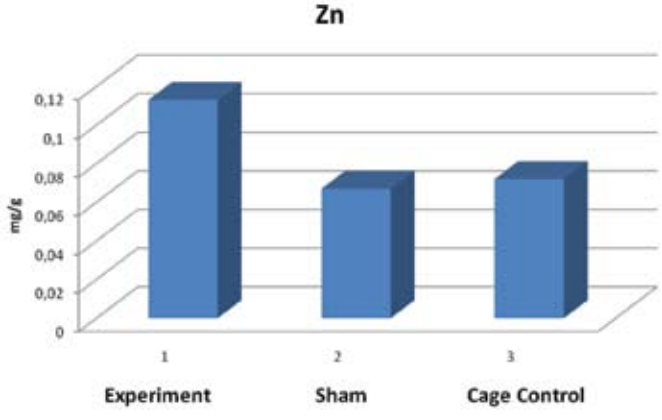

Fig. 6. Differentiation of Zn among groups

The body of an adult human normally contains about 1200 g of calcium. At least 99% of this is present in the skeleton, where calcium minerals, provide the hard structure of the bones and teeth (22). The results of this study showed that GSM-Modulated 900 MHz radiofrequency radiation does not affect the levels of Ca and P in rat teeth.

Magnesium is one of the most abundant elements in the earth's crust. It is widespread in food particularly whole grain and green vegetables. Mg is a cofactor in many enzyme systems and play an important role in the regular development of enamel and dentin, and the mineralization and binding of Ca and P (18).

The decrease of magnesium concentrations, which were measured in this study is in agreement with the results of Burchard et al. (8). These authors reported that electric and magnetic fields led to decline of Mg concentration in blood plasma.

Zinc plays an important role in the formation and metabolism of mineralized tissues, also animal studies suggest that the contents of zinc in teeth may reflect absorption of the metal. However, the zinc concentrations varied significantly with caries status, tooth type and root length (16). Therefore, the implications of excess Zn and its link with caries prevalence revealed that would also be an important area for further research. We suggested that GSM-Modulated 900 MHz radiofrequency radiation exposure, treatments can increase Zn

levels of rat's teeth statistically significant. The increase of Zn can be due to the affected Zn metabolism or by induction of enzyme systems.

One possible explanation for the trace elements of enamel and dentin affected by GSM-Modulated 900 MHz radiofrequency radiation treatment is that GSM-Modulated 900 MHz radiofrequency radiation field can alter chemical bonds of trace elements.

Several reviews on the issue of possible adverse health effects of mobile phones have been published (8, 9, 21) The fact that some environmental factors like GSM-Modulated 900 MHz radiofrequency radiation fields may have some harmful effects continues to arouse more interest especially in last two decades. Some literature has been reported that environmental effects such as GSM-Modulated 900 MHz radiofrequency radiation may affect health status in accordance with the altered physiological conditions (4, 14). For this reason, further studies are needed to reveal the effects of environmental factors on health status and oral tissues more clearly.

Conclusions

This preliminary study demonstrates the ability to determine the trace elements contents' distributions in rat's teeth which are treated with mobile phones and radiofrequency.

Our study demonstrates that the crowns of rat's teeth in the groups of experimental, sham and cage control involve significantly different contents of certain elements.

It may be concluded that the contents of the major and trace elements such as Ca, and P do not differ significantly in rat's teeth. While the content of Mg trace element decreases, Zn content increases significantly. It indicates that there is a positive evidence in rat's teeth, and it supports the hypothesis that GSM-Modulated 900 MHz radiofrequency radiation is related with changes in Mg and Zn amounts. However, this does not exclude the possibility that GSM-Modulated 900 MHz radiofrequency radiation plays an important etiological role in mineralization.

We believe that our results, which have been obtained from study on animals, should be further investigated by histologic, endocrinologic and epidemiologic studies.

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