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Original Article

Fluctuations in thyroid and parathyroid hormones and serum calcium in male rats treated simultaneously with radioiodine and nonionizing radiation

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ABSTRACT

Introduction: High levels of radiation can lead to harmful effects. But scientists have not reached a collective agreement on the effects of low doses of radiation. In the range of doses used by the general public and most pathogens, no epidemiological evidence is available about the harmful effects of ionizing radiation. Materials and Methods: 48 male homogeneous male rats with the same genetic structure in the range of 250 to 300 g were used. Mice are divided into four groups of 12 in bipartite groups. The first group named Control the second group received 1 Mci of radioactive iodine through oral gavage. The third group was exposed to mobile waves for conversation for 1 hour a day in the form of isodose get 14 weeks. The fourth group receives both oral and two weeks mobile phones. After the scheduled date, 2 cc of blood was taken from the heart of the mice and sent to the lab to test the TSH, PTH, CA tests. Results: PTH level was significantly increased from 50.26 ± 10.91 in the control group to 78.06 ± 15.86 in the iodine group 131 and 83.9 ± 9.19 in the combined group (p <0.0005). However ,the changes in the mobile group were not significant compared to the control group .The TSH level significantly increased from 4.94 ± 0.90 in the control group to 5.75 0.52 ± in the mobile group, 6.42 ± 0.98 in the iodine group 131 and 7.49 ± 0.74 in the combined group (p .(0.0005> There is no significant difference between mobile groups and Iodine 131 (p = 0.119 .(The increase in TSH level in the combined group was significantly higher than that of the mobile and iodine groups 131 (p ,(0.005> which indicates a synergistic effect. Conclusion :According to the results, and according to the previous studies and comparison of the results, it is concluded that the change in thyroid and parathyroid hormone occurs both with ionizing and non-ionizing electromagnetic waves .Exposure at the same time definitely creates a synergistic effect on calcium. The results were negative, so it would be advisable for patients who receive radioactive iodine to minimize exposure to RF-EMF waves and to check the levels of these hormones with regular tests.

Keywords: thyroid and parathyroid hormones, calcium, radioiodine, nonionizing radiation

Introduction

For many years, scientists know that exposure to radiation creates potentially harmful effects on tissues and cells, and adequate intensity of radiation may cause irreversible tissue damage, e.g. malignancy and even death of a living organism [1].

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Radioiodine is used to treat thyroid disorders [2].

When iodine is absorbed by the thyroid, treatment starts with beta radiation, and apoptosis occurs in malignant cells after a few weeks or months [3].

Resulting damage, if not repaired, will lead to death or prevention of inheritance, or result in a mutated or damaged living cell. Thus, for the patient with these cells, two completely different results can be achieved. Most organs or tissues are not affected by the loss of multiple cells, but if the number of cells lost is large enough, the tissue will not work properly and damage occurs. Probability of damage is proportional to the amount of radiation. For example, minimum doses required to produce a detectable cataract and temporary infertility are about 2, and 4 Gy, respectively. These doses are constant and definite [4].

If the cell exposed to radiation is alive but changed, the result will be very different. Cancer and hereditary effects belong to this category. If somatic cells are irradiated, the risk of developing cancer increases with increasing radiation dose. This is probably without a threshold effect, but severity of cancer is not dose-related. Cancer induced by 1 Gy is not the same as a cancer induced by 0.1 Gy (10 rad), but the probability of induction increases. These effects are called potential effects. Human has always been exposed to radiation from two main sources: 1) radiation from radioactive material around and inside our bodies; 2) radiation from artificial sources. We know that exposure to ionizing radiation is harmful to living organisms and adequate intensity of radiation may cause irreversible biological damage [4].

According to physics of vibrations and waves, electromagnetic waves propagate through the vacuum or a material medium. These waves consist of electric and magnetic fields oscillating in phase and perpendicularly to one another. Electromagnetic radiation is classified by frequency into radio wave, radar and microwave, infrared, visible light, ultraviolet, X-rays and gamma rays. These waves are widely used in daily life devices and equipment such as refrigerators, freezers, televisions, radios, microwave ovens, photocopiers, computer screens, halogen lamps and printers. Microwaves are a form of electromagnetic radiation with wavelengths ranging from one meter to one millimeter. Waves emitted by mobile phones with an average frequency of 900 MHz are also in this frequency range[5]. These waves produce different harmful effects in irradiated molecules according to radiation intensity and frequency [6]. In recent years, the overuse of mobile phones have caused many concerns about their harmful effects on human health. A number of important non-thermal biological effects such as changes in cell function, including widespread genetic changes leading to cell death, decrease in production of melatonin, and changes in human electroencephalogram associated with fixed and mobile phone antennas were reported in the literature [7]. Considering diagnostic and therapeutic application of radiation, operators and users exposed to radiation are worried about its harmful effects [8-10]. According to literature review, the main target of radiation is cell nucleus. Radiation causes damages such as chromosomal abnormalities, chromosomal instability and genotoxicity. Radiation can also affect future generations' genes [11]. Among these disorders, single and double strand chromosome damage is very important due to being associated with malignancies, so that observing chromosomal instability can help predict the risk of some malignancies and, if necessary, prevent them [11] . Since about half a century ago, radioactive substances have been used in clinical diagnosis and research. These substances were originally used to trace metabolic pathways in physiology and pathology. But today, it also plays an important role in imaging. Radioactive substances are used in radiobiology of nuclear medicine [12]. According to my research focused on thyroid cancer patients referring to the Department of Nuclear medicine, Namazi hospital, Shiraz, Iran, thyroid cancer is much more common in young and middle-aged women. Its prevalence is moderate. The most common types of thyroid cancer are papillary and follicular, which are surgically removed after diagnosis, and since cancer cells absorb iodine just like normal cells, after surgery, the best method is ionization or ablation, which is done at different doses based on the nature of tumor. Therefore, ionization therapy is done to ablate the residual thyroid tissue or possible metastasis. Thyroid cancer cells absorb iodine, so iodine concentrates in the residual thyroid cells and ablate them, and healthy cells that do not absorb iodine will remain safe. Radioactive iodine 131 has worked very well in treating thyroid cancer so far [13-16].

Methodology

In this study, 48 consanguineous and homogeneous male rats with the same genetic structure and weights ranging from 250 to 300 grams were tested. These rats were collected from the animal house of Shiraz University of Medical Sciences. Under standard conditions and with the help of technician of the animal house, the rates were divided into four groups in a double blind trial. The first group was considered as the control group. The second group received 0.1 Mci radioactive iodine by oral gavage. The third group were exposed to isodose mobile waves for 14 days, 1 hour a day, so that mobile phones were placed above the cage covering the whole cage. The phones were silenced to prevent noise pollution. In order to study the synergistic effect, the fourth group was given orally iodine and also exposed to mobile waves for two weeks.

After the prescribed time period, the rates were anesthetized with ether and 2 cc blood samples from their hearts were taken by a PhD student in physiology under completely standard conditions. The samples were poured into clot tubes of Nemazi Hospital and sent to laboratory .

Finally, the collected data were analyzed using spss.v.22 software. The chi-square test and OneweyANOVA analysis were used in this study.

Results

Collected data were analyzed uding SPSS v.20. Descriptive statistics were used to describe different groups. OneweyANOVA analysis was used to analyze and compare different groups. To perform this test, the following assumptions were examined and the obtained results were used for OneweyANOVA analysis.

The factors measured in the case study groups

The levels of calcium (Ca), parathyroid hormone (PTH) and thyroid stimulating hormone (TSH) in the case study groups, i.e. control group, mobile waves, iodine 131 (I131) and mobile waves plus Iodine 131 (Mobile + I131), are measured and include number of cases, mean, standard deviation, standard error, minimum and maximum for each group .

Bar graph of the mean calcium (Ca) levels measured in the case study groups.

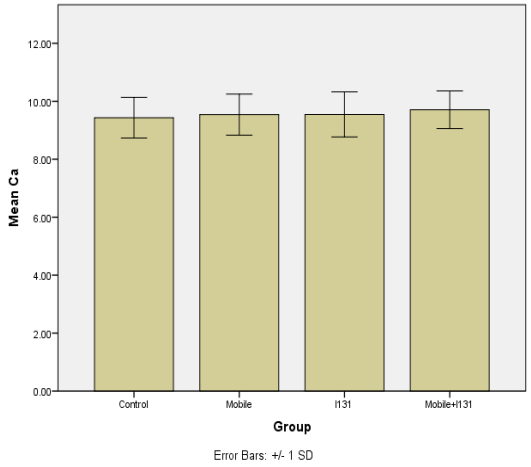

Diagram 1: mean calcium (Ca) levels measured in the case study groups

Bar graph of the mean parathyroid hormone (PTH) levels measured in the case study groups

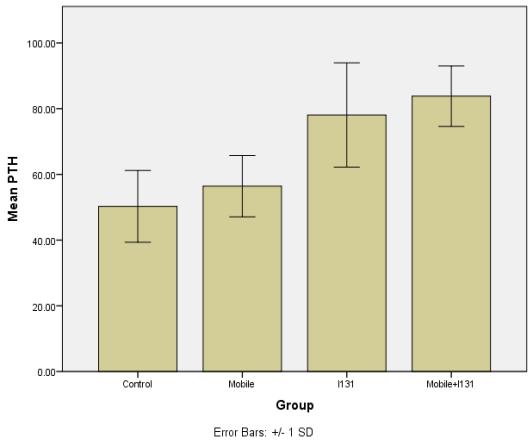

Diagram 2: Mean PTH levels measured in the case study groups

Bar graph of the mean thyroid stimulating hormone (TSH) levels measured in the case study groups

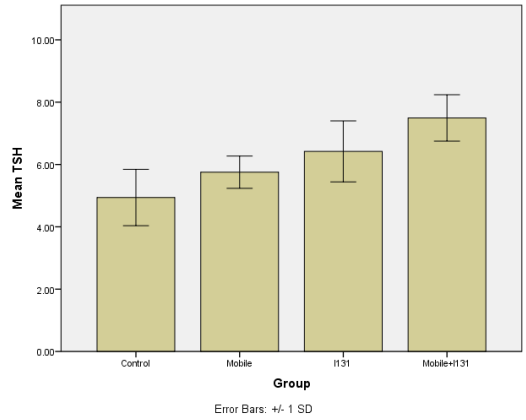

Diagram 3: Mean TSH levels measured in the case study groups

The results obtained from One-way ANOVA analysis

The results obtained from one-way ANOVA analysis are presented in **Diagram 1-3**. As can be seen, for calcium levels, p value was greater than 0.05, so there was no statistically statistical difference between the groups .However, there were statistically significant differences in the levels of PTH and TSH hormones between the groups.

Ca: $F(3, 56) = 0.377$, $p = 0.770$
PTH: $F(3, 56) = 29.403$, $p < 0.0005$
TSH: $F(3, 56) = 26.939$, $p < 0.0005$

Tukey HSD post hoc test for PTH and TSH was used for comparison. The results obtained from comparisons are presented below.

As shown in Diagram 2, PTH levels increased significantly from 50.26 ± 10.91 in the control group to 78.06 ± 15.86 in the iodine 131 group, and 83.19 ± 80.9 in the combined group ($p < 0.0005$). However, the results obtained from the mobile group were not significantly different from the control group ($p = 0.479$). In addition, there was no significant difference between iodine 131 and combined groups ($p = 0.536$) (Diagram 2). TSH level significantly increased from 4.94 ± 0.90 in the control group to 5.75 ± 0.52 in the mobile group, 6.42 ± 0.98 in the iodine 131 group, and 7.49 ± 0.74 in the combined group ($p < 0.0005$). There was no significant difference between mobile and Iodine 131 groups ($p = 0.119$). The increase in TSH levels in the combined group was significantly higher than the mobile and iodine 131 groups ($p < 0.005$), which indicates a synergistic effect (Diagram 3).

Gholamali Jeloldar et.al, investigated the effect of mobile microwaves on the serum levels of thyroid, cortisol and parathyroid hormones in adult and immature female rats. In this study, maturity of 40 female rats were tested in 4 groups. Animals were exposed to a 900 MHz electromagnetic pulse generator at a distance of 60 cm, for a period of 60 days and 4 hours each day. Control groups were exposed to the same lighting and temperature in the laboratory. After taking blood samples from the heart, serum levels of thyroid, cortisol and parathyroid hormones were tested using a diagnostic kit and radioimmunoassay. The results showed a significant decrease in hormone levels [17].

In my research on hormone fluctuations caused by electromagnetic waves, I found the study conducted by Dr. Seyed Mohammad Javad Mortazavi et al. on fluctuations in thyroid hormones caused by mobile waves. They observed decrease in the levels of hormones in people highly exposed to electromagnetic waves [18] .

Babi et al. investigated the relationship between radiation and thyroid disorders among mobile phone users. They studied 83 undergraduate students and found a decrease in the level of thyroid hormones in students who used their mobile phones too much [19]. This research is one of a very few studies that explicitly address mobile phone users, and among the nearly 60 resources I reviewed, its findings was quite close to my own study.

There has been little research conducted on the changes in parathyroid hormone and calcium, but Richard A. Luben et al., studied the effects of electromagnetic stimulator on bone and bone cells in inhibition of responses to parathyroid hormone by low-energy low-frequency fields. The results showed a decrease in calcium and parathyroid hormone caused by exposing to low frequency electromagnetic waves [20].

Klein Hesselink studied the simultaneous changes in both TSH and PTH in patients with low risk of thyroid cancer and treated with radioactive iodine. TSH and PTH levels were changed in the patients, indicating the extent of damage in radioactive iodine treats. I observed reproducibility of these results by comparing them with my own study [21].

In recent years, wireless networks have been widely used in places like business organizations, government institutions, universities, schools, and even homes. Flexibility, cost-effectiveness and rapid installation are some of the factors that help develop this technology [22].

In this study that I found a keen interest in radiobiology of non-ionizing radiation in the last decade. A number of epidemiological studies have shown the effect of EMF waves on health of human.

Risk of depression and cancer is increasing in people exposed to electromagnetic waves. Generally, low frequency electromagnetic fields cannot affect metabolic activity due to their low energy levels [22]. There was no significant difference in the average calcium levels of different groups and calcium levels remained unchanged in all groups.

According to the previous studies and the results obtained from the present study, it can be concluded that both ionizing and non-ionizing radiation can change thyroid and parathyroid hormones and simultaneously exposing definitely produces a synergistic effect. For calcium, the results were negative. Therefore, patients treated with radioactive iodine should minimize their exposures to RF-EMF waves and to regularly test levels of these hormones.

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Conflict of Interest

The authors report no declarations of interest.

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