

Mobile Phone Radiation and Human Serum Components: A Short Literature Review on Recent Findings

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Abstract: In recent years, a growing concern about the possible health hazards of mobile phones radiofrequency radiation has increased considerably among almost everyone in the world, even on those who do not have such phones. Moreover, new technologies, which use the spectrum of high frequency emissions, are incorporated in many aspects of telecommunications. As a consequence, there is a lot of interest about the possible effects of the radiation emitted from the cell phones which are engaged in the telephony. This paper presents a review on recent findings of our research team on the effects of cell phones radiation on human serum chorionic gonadotropin (hCG), ferritin and triiodothyronine (T3) levels.

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1. Introduction

In recent years, various and profound investigations have been carried out in order to investigate the possible biological effects of mobile phones radiofrequency (RF) radiation on mammals, including the human population [1, 2]. Herein, a growing concern about the possible health hazards has increased considerably among almost everyone in the world, even on those who do not have such phone [3-5].

The mobile phone technology is consist of RF radiation with transmission of microwaves carrying frequencies between 880 and 1800 Mega Hertz (MHz) [6]. There is an increasing number of cell phone users all over the world and the question is whether Micro Wave (MW) of these instruments could cause health hazards [7-11]. Moreover, new technologies, which use the spectrum of high frequency emissions, are incorporated in many aspects of telecommunications. As a consequence, there is a lot of interest about the possible effects of the radiation emitted from the cell phones which are engaged in the telephony [12-14].

Many studies have been performed with the aim of setting up suitable "in vitro" or "in vivo" tests capable of assessing biological effects induced by cell phones radiation [9, 10, 15-21]. From another point of view, many studies have been carried out or are in progress about the various effects of radiation emissions in regarding to the behavior, cancer, central nervous system, sleep, children,

cardiovascular system, immune function, reproduction and development [9-11, 19-22]. Nittby et al. have investigated that mobile phone exposure affects the mammalian blood-brain barrier permeability 7 days after exposure to the radiation from a 900 MHz global systems for mobile (GSM) communications [23, 24]. Hinrikus et al. have shown that, the human brain EEG beta rhythms energies were increased by exposure to 450 MHz MW [25]. Lai et al. investigated the effects of microwave exposure on cholinergic systems in rat brain showing that, it is possible to establish a dose-response relationship for each brain region when different microwave power densities are used [26, 27]. Recent experimental studies in mice have shown that exposure to EMF led to significant testicular germ cell apoptosis and morphological changes [28-30]. Lu et al, have found that household use of air conditioners, which generate significant amounts of EMF, has been associated with low semen quality [31].

This paper presents a review on recent findings of our research team on the effects of cell phones radiation on human serum chorionic gonadotropin (hCG), ferritin and triiodothyronine (T3) levels.

1.1. Human Chorionic Gonadotropin (hCG)

Human chorionic Gonadotropin (hCG) is a glycoprotein with approximately 9% of sialic acid and 30% carbohydrate. Serum hCG appears early

during pregnancy and its concentrations increases gradually by reaching a peak at the end of the first trimester, after which it progressively decreases until delivery. It is secreted during pregnancy by syncytiotrophoblast cells of the placenta. Chorionic Gonadotropin testing constitutes an important tool for monitoring pregnancy, especially during the first trimester. In fact, during this period it is important to perform serial determinations to find out if there is a threatened abortion [32-37].

Human chorionic Gonadotropin level can easily be tested in "in vitro" preparations using a spectrophotometer, and thus, it provides a suitable model system to study the influence of RF emission on chorionic Gonadotropin [38-43].

Shahbazi et al, investigated the effects of cell phones radiation on hCG hormone levels in assays in laboratory [13]. They found that radiation exposure from mobile phones altered the measured serum levels especially in the wells with 100, 250, 500 mIU/mL hormone concentrations. Moreover, their results showed that exposure at 1.09 W/kg SAR caused a significant loss compared to 0.69 W/kg SAR exposure. They concluded that, the microwave exposures may require attention in laboratories using immunoassays.

1.2. Human Ferritin

Iron (Fe) is an essential micronutrient in biological systems and plays an important role in several cellular processes, such as adenosine triphosphate (ATP), deoxyribonucleic acid (DNA), and neurotransmitter synthesis [44]. Tissue iron is stored inside a porous protein capsule called ferritin [45-47]. Ferritin is a macromolecule and is responsible for the long term iron storage function mainly in the liver, spleen, and bone marrow [37, 48-52]. Many diseases are associated with iron overload or iron deficiency. Determination of ferritin is a suitable method for ascertaining the iron metabolism situation which provides a representative measure of body's iron reserves [53]. For determination of ferritin, human serum is labeled with ruthenium to form a sandwich complex based on an immunoassay technique [53, 54].

Fattahi et al, showed that human serum ferritin level could be interfered by the exposure to the cell phones [55, 56]. Their results demonstrated that, human serum wells in the exposed batch showed a significant decrease in serum ferritin relative to the control batch ($P = 0.029$). The average \pm SD ferritin level in the exposed batch was 84.94 ± 1.04 μ g/L while it was 87.25 ± 0.83 μ g/L for the unexposed batch. They stated, "radiofrequency electromagnetic waves emitted from cell phones may lead to oxidative stress and rapid diffusion of the human

ferritin level in an *in vitro* enzymun assay. Also, the enzyme activity can be affected."

1.3. Human Triiodothronine (T3)

Thyroid activity is regulated by the TSH secreted by pituitary. Elevated TSH levels induce the thyroid to elaborate T3 and thyroxin T4, a hormone which functions in at least 20 enzyme systems; one of its major influences involves the acceleration of protein synthesis. T3 is the hormone principally responsible for the development of the effects of the thyroid hormones on the various target organs [32, 33, 57-60]. Accordingly, the T3 concentration in serum is more a reflection of the functional state of the peripheral tissue than the secretory performance of the thyroid gland [61]. A reduction in the conversion of T3 results in a decrease in the T3 concentration. The determination of T3 is utilized in the diagnosis of T3-hyperthyroidism and for the detection of early stages of hyperthyroidism [61].

Fattahi et al, showed that mobile phone radiation did not affect the T3 levels in human serum. In other words, radiation exposure from mobile phone did not alter the serum T3 levels in the exposed wells [62]. In their experiment, the final average \pm SD of T3 level in the control and exposed group was 4.93 ± 0.34 and 4.55 ± 0.53 μ g/L, respectively. Fattahi et al, concluded that, although there was no significant difference in serum T3 in the exposed group compared to the control, but, more accurate follow up studies are needed for the evaluation of the effects of the mobile phone use.

2. Discussion

Recent findings showed that, human serum hCG and ferritin levels labeled with ruthenium were affected following mobile phones exposure [63-67]. The reason could be due to oxidative stress and rapid diffusion at high electromagnetic irradiation and field caused by mobile phone. Moreover, the enzyme activity can be affected [68-70].

Microwaves can affect the serum components by a MW specific, non-thermal action, and a thermal molecular effect, or a combination of these mechanisms [22, 41-43, 71, 72]. However, it is commonly accepted that MW emitted by mobile phones is at a non-thermal power density level [47-53].

It has been shown that RF fields at 300 MHz to several GHz, at which significant local and non-uniform absorption occurs, induce torques on molecules that can result in displacement of ions from unperturbed positions, vibrations in bound charges (both electrons and ions), and rotation and reorientation of dipolar molecules such as water [3].

The recent findings presented here were in a good agreement with previously published literature

[31-33]. Diem et al, reported DNA single- and double-strand induced breaks due to 1800 MHz RF-EMF exposure at 1.2 W/kg SAR [73]. Ammari et al. investigated the effects of a chronic GSM 900 MHz exposure on glia in the rat brain. They have concluded that chronic exposure to 900 MHz MW may induce persistent astroglia activation in the rat [74]. Barteri et al. studied the in-vitro interaction between RF radiation and proteins of different species. They have demonstrated that mobile phone exposure affects the structural and biochemical characteristics of an important CNS enzyme [75]. Nittby et al. have investigated that albumin extravasation enhanced in the rats which were exposed to mobile phones at 12 mW/kg SAR [23].

Recently, it is stated that, mobile phone radiation exposure does not alter the serum T3 levels in human serum. This result is in agreement with some previous studies that have found no significant EMF effects. Gurisik et al. showed no significant differences between sham-exposed and RF-exposed cells in any of the assays or conditions examined [76]. Lee et al. reported that 1763 MHz RF radiation alone did not elicit any stress response [77]. Lantow et al. demonstrated that RF-EMF exposure of human monocytes and lymphocytes did not have any activating capacity to induce hsp70 expression [78].

It should be noted that since each laboratory has its own conditions and instruments, results obtained in individual laboratories may differ from each other [38, 40, 50, 52, 79]. Considering immunoenzymometric assay in studies presented above, it has been reported that repeatability and precision of the results by using different test methods and analyzers may varied from 1.9% and 2.7% to 3.0% and 4.4%, respectively [39].

More accurate follow up studies are needed for the evaluation of the effects of the mobile phone use. The effects of mobile phones radiation should be confirmed in in-vivo situation and in larger series, employing repeated exposure-dose related effect design and providing a detailed assessment of RF radiation produced by the phones. However, still many of the related studies, in the field of mobile phone biological effects, are flawed by inconsistencies in exposure models, cell types used and the independent reproducibility of the findings.

3. Conclusions

Mobile phone radiation causes profound changes in the measured hCG and ferritin levels in immunoassays in laboratory. However, it does not affect T3 hormone in an in-vitro immunoassay under the conditions used. Further in-vivo studies on mammals are suggested, in order to evaluate the possible effects of mobile phones radiation.

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