EFFECTS OF 900 MHz ELECTROMAGNETIC FIELDS Emitted FROM A CELLULAR PHONE ON THE T₃, T₄, AND CORTISOL LEVELS IN SYRIAN HAMSTERS

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Abstract

The effects of exposure to a 900 MHz electromagnetic field (EMF) on the serum cortisol and triiodothyronine–thyroxin (T₃–T₄) levels in adult male Syrian hamsters were evaluated. Seventy-two hamsters were used in three independent groups: 24 served as controls (without exposure to stress and EMF), 24 were exposed to a 900 MHz EMF for 10 d, and 24 were exposed to a 900 MHz EMF for 50 d. The exposures were performed 1 h/d to a 900 MHz EMF emitted by cellular phones. The levels of cortisol and T₃–T₄ were measured by using an immunoradiometric assay (IRMA) method. The results revealed the cortisol values of the group, which was exposed to 900 MHz EMF for 50 d, were higher than those of the other groups (P <0.01). The levels of T₃ in the control group were higher than that of the long-term exposure group (P<0.01), and levels of T₄ in the 900 MHz EMF group for the long-term and short-term exposure groups, were higher than that of the control group (P <0.01). These results indicate that a 900 MHz EMF emitted by cellular phones, especially in the case of long-term exposure, increased the serum cortisol and T₄ levels and decreased the T₃ level, and suggest that it can destroy the endocrine system in general.

Key words: hamster, cortisol, T₃–T₄, electromagnetic field.

Material and Methods

Seventy-two male Syrian golden hamsters (each weighing 150–160 g at the time of the experiment) were
used. They were acclimated for 1 week prior to use, maintained on a 12 h light: 12 h dark cycle in a temperature–regulated (22-23°C) animal room with continuous free access to water and feed. The animal studies were carried out in adherence to the guidelines established in the “Guide for the care and use of Laboratory Animals, US Department of Health and Human Resources (NIH1985)”. The hamsters were kept in conditions similar to pet housing systems.

The study was conducted in summer 2007. The animals were divided into three groups: group 1 - the control group without any EMF exposure; group 2 - the short-term EMF exposure; and group 3 - the long-term EMF exposure. The animals were selected, and each of the exposed animals was maintained concurrently with those not exposed to EMF in separate cages. The animals included in the group 2, which were kept in separate aquarium-like glass cages covered with aluminium sheets, were under a 900 MHz EMF emitted by the antenna of cellular phones (Sony Ericsson® K750i, specifics: ON, SAR: 0.66w/kg) 1 h daily for 10 d. The animals included in the group 3, which were also kept in separate cages, were under a 900 MHz EMF 1 h daily for 50 d. The scheme of the exposures is presented in Fig. 1.

At the end of the experiment, the animals were anesthetised with chloroform, and blood samples were drawn from the heart ventricle into syringes (without anticoagulants), from all the experimental groups. The serum cortisol, T₃, and T₄ levels were measured by chemiluminescence immunoassay (Liaison Co®, Italy) and the values of the exposure groups (groups 2 and 3) were compared with those of the control group (group 1).

**Statistical analysis.** The data collected were subjected to an analysis of variance, and any significant differences were determined. When the ANOVA revealed significant differences, Duncan's multiple range tests was performed to establish where such means differed. All the data were analysed by ANOVA using the general linear model (GLM) procedures of the SAS Institute (15).

**Results**

In Table 1, the blood serum T₄, T₃, and cortisol levels of all the groups of hamsters are given. There was a significant difference in the serum levels of T₄ (P<0.01) and T₃ (P<0.01) hormones between the hamsters in the group 3 (exposed long-term to EMF) and the control group (without any EMF exposure). The serum T₃ levels in the group 2 with short-term exposure (73.00 ng/dL) did not change significantly, in comparison to the control group (73.03 ng/dL) (P<0.01). The differences in the T₃ and cortisol levels were significant among the groups with long-term EMF exposure and the control group (P<0.05).

![Fig. 1. Schema of conditions of exposure to cellular phone EMFs.](image-url)
Table 1

Serum concentrations of T₃, T₄, and cortisol in Syrian hamsters exposed to electromagnetic field (900 MHz)

<table>
<thead>
<tr>
<th>Experimental groups</th>
<th>Exposure time</th>
<th>T₃ (ng/dL)</th>
<th>T₄ (µg/dL)</th>
<th>Cortisol (µg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control without exposure</td>
<td></td>
<td>73.03a</td>
<td>2.52b</td>
<td>0.39b</td>
</tr>
<tr>
<td>Short-term exposure</td>
<td>10 d exposure</td>
<td>73.00a</td>
<td>2.94a</td>
<td>0.58b</td>
</tr>
<tr>
<td>Long-term exposure</td>
<td>50 d exposure</td>
<td>50.35b</td>
<td>2.87a</td>
<td>1.05a</td>
</tr>
<tr>
<td>SEM¹</td>
<td></td>
<td>1.23</td>
<td>0.54</td>
<td>0.09</td>
</tr>
</tbody>
</table>

¹ SEM, based on pooled estimate of variance and n: 3
a,b: Means within columns with no common superscript differ significantly (P<0.05)

Table 2

Effect of EMFs on serum cortisol level of rodents in different studies

<table>
<thead>
<tr>
<th>Reference number</th>
<th>Rodent</th>
<th>EMF Exposure time</th>
<th>Control group (without EMF) µg/dL</th>
<th>Exposure group µg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(6)</td>
<td>Rat</td>
<td>900 MHz 30 min/d, 5 d/week, 4 weeks 1,800 MHz</td>
<td>1.73</td>
<td>2.51</td>
</tr>
<tr>
<td>(7)</td>
<td>Rat</td>
<td>900 MHz 30 min/d, 5 d/week, 4 weeks</td>
<td>1.73</td>
<td>4.24</td>
</tr>
<tr>
<td>This study</td>
<td>Syrian hamster</td>
<td>900 MHz 60 min/d, 50 d</td>
<td>0.39</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Discussion

Cellular phones are placed beside the thyroid gland during phone calls. Therefore, the thyroid gland is one of the organs, which is exposed to EMFs. The effects of EMFs on hormonal excretion are variable with time (11). In our study, cortisol levels increased significantly with the 60-min daily exposure to a 900 MHz electromagnetic field for 50 d. Sadeghi et al. (14) reported increased glucose and cortisol levels in guinea pigs when exposed to 50 Hz MF (after 5 d and a daily 4 h exposure). They indicated that the MF causes an increase in the stress factors of the blood serum.

In this study, the T₃ serum level decreased with the increasing EMF exposure time. This result was in accordance with the reports of Koyu et al. (5) on the decrease in T₃ levels. The T₄ levels displayed significant differences in the groups 2 and 3 (2.94 and 2.87 µg/dL) compared to the control group (2.52 µg/dL). Our results on the T₄ level differed from those reported by Koyu et al. (5), with 900 MHz. However, these results were in agreement with those obtained with a 1,800 MHz electromagnetic fields (7). The researchers mentioned that stress affects thyroid gland activity. The increase in the excretion of glucocorticoids constitutes an obstacle for the conversion of T₄ into T₃ (16). Therefore, according to these results, which are in agreement with each other, as the T₄ hormone increases, T₃ decreases. As a matter of fact, this is not related to the conversion of T₄ into T₃ due to EMF-induced stress. Koyu et al. (7) reported significant differences in T₃, T₄, and cortisol levels upon exposure to a 1,800 MHz EMF. In another study carried out by these researchers, the levels of these same hormones were determined to decrease as a result of exposure to a 900 MHz EMF (Table 2) (5). These authors also reported that no significant difference occurs in the thyroid hormone levels, as stress is very common. It has been shown that long-term stress increases cortisol levels (Table 2) (13).

Other stress factors in blood (such as glucose) were reported by Sadeghi et al. (14) to increase. The results of the present study on the cortisol are in agreement with those reported by Radon et al. (13), Koyu et al. (6, 7), Sadeghi et al. (14), and Vangeleva et al. (17). Based on these results, EMFs emitted by cellular phones, especially in the long-term, can cause stress in hamsters and increase serum cortisol levels. The conversion of T₄ into T₃ decreases, destroying the thyroid hormonal balance in general.

Djeridane et al. (2), in a similar study conducted with a 900 MHz EMF, reported that a 900 MHz EMF (2 h/d, 5 d/week, for 4 weeks) did not cause any significant changes in serum cortisol levels. However, according to previous studies (Table 2), a 900 MHz EMF may cause increased cortisol levels in rodents. Further experiments are needed to clarify whether the cortisol levels of humans can be influenced in the long-term as a result of exposure to a 900 MHz EMF emitted by cellular phones.

In conclusion, based upon the results obtained in the present study (using common hamster housing conditions and without being forced in being exposed to high intensity EMF), short-term exposure to a 900 MHz
electromagnetic field was determined to exhibit negative effects on the cortisol and T4 levels in hamsters, and long-term exposure was ascertained to negatively influence the T3, T4, and cortisol levels, thereby suggesting that the exposure time constitutes a significant factor in the indicated hormones.

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References