Short-Term Biochemical Effects of 900MHz Cell Phones on Rat Brains and Bodies

900MHz Cep Telefonlarının Sıçan Beyin ve Vücutlarındaki Kısa Dönem Biyokimyasal Etkileri

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Geliş Tarihi/*Received:* 23.03.2013
Kabul Tarihi/*Accepted:* 17.02.2014

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ABSTRACT Objective: The harmful effects of low-level electromagnetic radiation (LLER) of cell phones, were investigated in several studies before. In each study the subject was evaluated in a different perspective. Unfortunately, this issue has not been fully clarified. We have performed a study to examine the harmful effects of LLER from 900MHz mobile phones on the brains and bodies of rats. In this study three biochemical parameters (glutamine/glutamate, serotonin (5-HT), catalase) were evaluated all of whıch are closely related to cerebral and body functions. **Material and Methods:** In this study, 10 Wistar albino rats were used to show the effects of mobile phones on the rat's brain and bodies. Before the procedure, a blood sample was taken from all of the rats. These base values were used as control group. Subsequently, LLER (900MHz) was applied to their heads for 45 minutes. One and one-half hours later, blood samples were taken again and the results were statistically analyzed. **Results:** Complete examination of the results exhibits no significant change (p=0.72 and p=0.33, p=0.99 respectively) for the levels of glutamate, serotonin (5-HT) and catalase. **Conclusion:** When the blood samples were statistically evaluated for before and after the procedure both for glutamate, 5-HT and catalase; no significant result was obtained (p>0.05). However, when the rats were categorized with respect to their initial biochemical values, a significant elevation was observed for 5-HT (p=0.043).

Key Words: Cellular phone; electromagnetic radiation; serotonin; glutamine; catalase

ÖZET Amaç: Düşük Dozlu Radyasyonun (DDER) zararlı etkileri, daha önce de birçok çalışmada araştırılmıştır. Herbir çalışmada bu konu farklı bir perspektifle değerlendirilmiştir. Maalesef konuya net bir açıklık getirilememiştir. 900MHz düşük dozlu elektromanyetik radyasyon yayan cep telefonlarının sıçan beyin ve vücudundaki zararlı etkilerini belirlemek için yaptığımız bu çalışmada, beyin ve vücut fonksiyonları ile yakından ilişkili olan üç biyokimyasal parametreyi (glutamine/glutamate, serotonin (5-HT), catalase) ele aldık. **Gereç ve Yöntemler:** Bu araştırmada, mobil telefonların sıçan beyni ve vücudundaki etkisini göstermek için 10 adet Wistar Albino sıçan üzerinde çalışılmıştır. Bütün sıçanlardan işlem öncesi bazal değerler için kan alınmıştır. Bu değerler kontrol grubu olarak kullanılmıştır. Daha sonra sıçanların baş bölgelerine DDER (900MHz) 45 dakika süresince uygulanmıştır. Bir buçuk saat sonra tekrar kan örnekleri alınmış ve sonuçlar istatistiksel olarak analiz edilmiştir. **Bulgular:** Çalışmanın sonuçları incelendiğinde glutamat, serotonin ve katalaz düzeylerinde anlamlı bir değişiklik görülmemiştir (sırası ile p=0,72, p=0,33, p=0,99). **Sonuç:** Glutamat, serotonin ve katalazın işlem öncesi ve sonrası düzeyleri istatistiksel olarak değerlendirildiğinde anlamlı fark görülmedi (p>0,05). Ancak sıçanlar biyokimysal değerlerine gore kategorize edilerek iki gruba bölündüğünde, 5-HT için anlamlı bir yükselme dikkat çekmiştir (p=0,043).

Anahtar Kelimeler: Cep telefonu; elektromanyetik radyasyon; serotonin; glutamin; katalaz

Turkiye Klinikleri J Neur 2014;9(2):55-9

The harmful effects of low-level electromagnetic radiation (LLER) of cell phones on the brain and body have been a subject of much research in the past. However, a review of the literature that is built

upon this subject shows that each researcher handled this phenomenon from a different perspective. This study aims to contribute to the literature by providing a comprehensive conclusion by examining three important biochemical parameters: glutamine/glutamate, serotonin (5-hydroxytrytamine, 5-HT) and catalase/hydrogen peroxide (an oxidative stress marker). Moreover, our study also contributes by investigating the results of a single 45-minute application, while other studies generally examined the long-term effects of cell phone usage.

Mobile phones have been reported to seriously affect the hormonal systems and chemical makeup of humans.[1] Exposure to LLER through the long term usage of cell phones causes serious effects.[2] LLER variously affects the nervous system, increases the rate of cerebral tumor development, decreases sperm count, increases DNA fragmentation, and increases the risk of multiple sclerosis.[3-7] Most of these effects depend on the change of hormonal profiles. This study reviewed three separate parameters: serotonin (5-HT), glutamate and catalase, all of which are thought to affect cerebral and body functions.

Serotonin (5-HT), a monoamine neurotransmitter consisting of tryptophan amino acid, is most commonly found in the gastrointestinal tract, thrombocytes, and nerve system of the body. Serotonin is necessary for intestinal movement, sleep, appetite, conscious functions, and learning.[8,9] When serotonin is at a normal level, people feel better, happier. Deficiency of serotonin may cause depression, nausea, vomiting, and diarrhea. Serotonin is released from the ventromedial nuclei and enterochromaffin cells in the bowels. Serotonin (5-HT) receptors are in the hippocampus region in the brain.[10] In humans, deficiency of serotonin has been found in sudden infant death syndrome (SIDS).[11] A different but equally fatal serotonin syndrome occurs with high doses of serotonin.[12]

Glutamine and glutamic acid, glutamate are glucose-like chemicals used for energy when glucose is not available. Glutamate can easily pass the blood-brain barrier; therefore, it is one of the most important source of energy. It also regulates the cerebral and muscular functions by elevating the level of gamma amino butyric acid (GABA). Glutamate provides cleaning of ammonia from the brain thus delaying cerebral ageing. Glutamine and glutamic acid, glutamate are used in the treatment of schizophrenia and senility, loss of muscular strength, and to increase intelligence as a supportive treatment, but excess is harmful.[13] Excess of catalase may cause degeneration in cells such as death of cells, cancer and early ageing, asthma, romatoid artritis, by increasing oxidative stress in the body with free radicals and an oxidant effect.[14,15]

MATERIAL AND METHODS

STUDY DESIGN

This is an animal study for exploratory experimentation.

STUDY POPULATION

To show effects of mobile phones on an organism, this study used 10 male Wistar albino rats, 4 months old, weighing from 250 to 300 g. At the beginning of the study and before the procedure, blood samples were taken from all ten rats in order to determine base values. These base values, then, formed the control group. Before blood was drawn, the rats were grouped by three and intraperitoneally anesthesized by cetamine (35 mg/kg) and xylazine (5mg/kg). Anesthetic time was 120 minutes. After the procedure of bloodletting was completed, the rats were placed onto their special places on a plexi-glass flat ground prepared previously.

LABORATORY

Samples: 0.5 ml blood was taken from the rats' tail veins, put into lithium tubes, and stored at -80 degrees until biochemical analysis was made.

MEASUREMENTS

Assay of 5-HT Levels: Plasma 5-HT levels were measured by enzyme immunoassay (EIA) using a 5-HT kit (Cusabio Biotech Co., Ltd., China). The coefficients of intra- and inter assay variations were <10%.

Assay of Glutamate Levels: Plasma glutamate levels were measured by enzyme immune assay (EIA) using a glutamate kit (Cusabio Biotech Co, Ltd., China). The coefficients of intra- and inter assay variations were <10%.

Assay of catalase levels: Plasma catalase levels were measured by manual spectrophotometric enzyme technique.

Because the frequency emitted by cell phones is not stable, a fixed equivalent frequency emitter device was used. Sign Generator: R&S SMBV100A, Transmitting antenna: Agilent 11965A, Field measurement: Spectran HF-6080. A sign to be an electromagnetic field 15.14 V/m (608mW/m2) in strength in the head region with 100kHz FM modulation at 900MHz was applied to the animals (Figure 1).

Frequency measurements with the device were done with the rats positioned side by side. LLER doses received by the brain were calculated to be equivalent by putting rats in groups of one or four. The 10 rats were grouped side by side in groups of three and four (Figure 2). After calculating the ideal position for the device, electromagnetic LLER energy was applied for 45 minutes from a distance to be equal with energy transmitted by a mobile phone from a 0.5-1 cm distance to their head regions. After 1.5 hours and before the rats were awoken, blood were again drawn from their tail veins. This amount of time was needed for peak values of 5-HT and glutamate to be realized. A longer wait would have required the administration of repetitive anesthetic agent, which could have negatively affected biochemical data.

FIGURE 1: Frequency meter device.

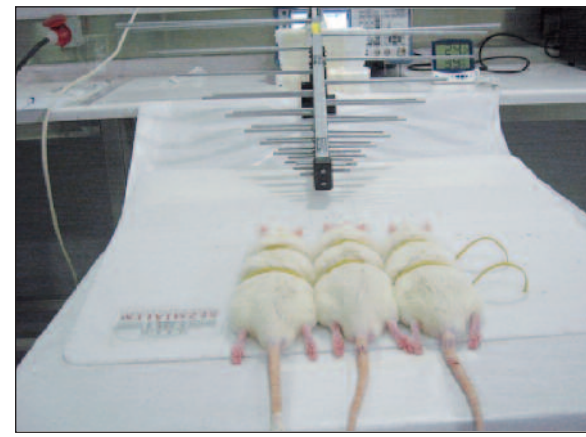

FIGURE 2: Rats during LLER application in position and distance specified after measurements.

STATISTICS

Numerical variables are presented as means (with standard deviations) and nominal variables (in ratios). Rat groups are evaluated before and after application. Ordinal paired variables are compared using the Wilcoxon test for 5-HT, glutamate and catalase levels, and the before application and after application groups. A p value of ≤0.05 was considered to be statistically significant.

ETHICS

The study was approved by the Animal Ethics Committee of the Bezmialem Vakif University Medical Faculty. Animal rights were respected.

RESULTS

In this study, Wilcoxon analysis showed that there exist no statistically significant difference between before and after values of 5-HT (p=0.33), glutamate (p=0.72) and catalase (p=0.9).

When the rats were divided into two groups according to their biochemical data, the results were found to be significant only for 5HT. In 5 rats whose pre-application 5-HT values are 91 or under 91, an elevation was seen for according to post-application values. On the other hand in 5 rats whose pre-application 5-HT values are above 91, a reduction was seen for post-application values (Table 1,

Table 2). Accordingly, Wilcoxon analysis results for 5-HT in 5 rats whose pre-application 5-HT values that were under 91 are statistically significant (p=0.043). Wilcoxon analysis results for 5-HT in 5 rats whose pre-application 5-HT values were above 91 are not statistically significant (p=0.22).

DISCUSSION

When the values before and after the procedure both for glutamate, 5-HT and catalase were statistically evaluated after a 45 minutes of LLER application, no statistically significant results were obtained. However, when rats were divided into two separate groups according to their blood values, the results were pronouncedly significant for serotonin. In 5 rats whose onset serotonin values, before the procedure are 91 or below, it is observed that the elevation in 5-HT values that is seen after the procedure is significant (p=0.043). Conversely, in the other 5 rats whose values above 91, a decrease was seen in the values after the procedure (p=0.077).

The rats with high onset 5-HT values are those with more intense stress which caused their serotonin values to reach maximal levels just at the moment when they are taken in hand at the beginning of the anesthetic procedure.[16] The release level of serotonin thereafter went into an unavoidable decline after it exceeded its maximal capacity.

In other similar studies in the literature, LLER waves were applied to rats for a much longer period, e.g., between 45 days and 6 months, after this procedure, the samples were taken from cerebral tissues of rats and examined.[17,18] We tried to show the effects only within a 45 minute period of time and only for over 5-HT, glutamate, and catalase. Our aim was to show change in biochemical data resulting from a single, long-term call. The base values in blood samples received before the procedure formed the control group. In other studies in the literature, data had been obtained mostly with cerebral tissue. If we had made an examination of the cerebral tissue, the rats would have died and we would have been unable to take a usable blood sample 1.5 hours later. We thought to obtain short-term effects best with this method. An increase was seen in serotonin values as a result of short-term LLER application in rats which had no intensive stress and on which onset serotonin values were below 91. In this group, only serotonin (*p=0.043*) was found statistically significant. When the literature was reviewed, no significant results were able to be obtained with short-term LLER application.[16] Rats in general have an extreme physical/biological response to stress, but individual responses may vary.[17] Rats were observed to be exposed to unpredictable stress when they were held by hand for the procedure, therefore, variable results were noted in such biochemical tests.

In our study, obtaining a significant value for serotonin and a value close to this for glutamate are quite important. From now on, these findings should be supported with studies to be performed with other chemicals and probably through thermal cameras. In future studies, other stress elements except from the cell phone should be minimized.

TABLE 1: Wilcoxon analysis results for 5-HT in 5 rats of which 5-HT value before the procedure is ≤91 p=0.043 and found significant.

5-HT	Mean ± SD (nmol/ml)	p
Before application	77.4±13	0.043
After application	195.5±116.9	

TABLE 2: Wilcoxon analysis results for glutamate in 6 rats of which glutamate value before the procedure is ≤197 p=0.07 not found significant.

Glutamate	Mean ± SD (nmol/ml)	p
Before application	181.8±16.3	0.07
After application	204.04±12.7	

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