



Research Paper

Evaluation of the Effect of Protracted Exposure of Rats to Mobile Phone Radiation

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Abstract

This study is aimed at investigating the effect of radiation from mobile phone on body weight and haematological indices of male wistar albino rats. In this study, male wistar albino rats were continuously exposed to Radiofrequency electromagnetic radiation (RF-EMR) with frequency 900 MHz for 0, 4, 8 and 12 h per day for 30 days. The body weights of the animals were taken at 5-day interval. At the expiration of the experimental period, haematological parameters of the blood were evaluated. The results showed that repeated exposure to mobile phone radiation evoked a reduced body weight and decreased level in red blood cell, packed cell volume and haemoglobin in rats and this effect was markedly amplified with increased exposure duration to the RF-EMR. Intriguingly, there was a direct relationship between exposure duration and frequency to mobile phone radiation and the level of white blood cell counts. In conclusion, the present data provide a strong line of reason to suggest that increased exposure to mobile phone radiation may evoke anaemic condition and predispose frequent users of mobile phone calls to decreased immune system and opportunist infection.

Keywords: RF-EMR; Haematological parameter; Exposure duration.

Introduction

The advancement of mobile telecommunication system has grown rapidly in recent years to become one of the most successful inventions of the 20th century [1]. According to Statistic, the number of mobile phone users in the world is expected to be 4.68 billion by 2019, which is about sixty-two point nine percent (62.9%) of the world's population [2]. Mobile phones are non-ionizing radiation (NIR) which falls to the category of radiofrequency (RF) radiation which operates in the frequency range of about 900 to 2,200 Megahertz (MHz)[1]. The widespread use of mobile phones in recent years has raised concern about their safety, because the user is frequently being exposed to non-ionising electromagnetic radiation (EMR) in the ultra-high frequency range. EMR emitted by mobile phones can inflict their effects both by thermal and

non-thermal impact. The emitted non-ionising EMR is suspected to underlie several health issues, such as headaches, fatigue, behavioural problems, cognitive deficits, reduced fertility, and brain tumor development [3-6]. Although, there is accumulating evidence that EMR from mobile phone has deleterious effect on human health. According to [7] several haematological parameters are sensitive to EMR from mobile phone. In fact, [8] investigation showed that EMR from mobile phone caused decrease in red blood cell, haematocrit value and increase in white blood cell of exposed animals. Furthermore, [9] proved a relationship between exposure to electromagnetic radiation from mobile phone and blood cancer. On the other hand, some studies have shown that there is no damage to the blood as a result of exposure to EMR from mobile phone [10, 11]. However, these evidences are inconclusive and thus, open for further investigation.

The purpose of this study is to evaluate the effect of protracted exposure of mobile phone radiation on rats. The effects on body weight and haematological parameters were investigated.

Materials and Methods

Electromagnetic Source

Cell phones which have a personal communications service code division multiple access (PCS CDMA) frequency band of 2G network, 900MHz were used as a source of electromagnetic radiation. The cell phones used in the study were ITEL 5600 (China). The cell phones were placed inside the plastic cages and a call was made from another mobile phone at 2 hours interval. The phones were also allowed to ring.

Animal Preparation and Exposure

Thirty-two male wistar albino rats, weighing 100-120g, divided into four groups of eight rats each were used for the experiment. The animals were kept in plastic cages and were left for seven days for acclimatization in the laboratory. They were allowed free access to water and normal pellet diet throughout the experimental period. After acclimatization the rats were exposed to different duration (0, 4, 8 and 12 hours) of 900 MHz non ionizing radiation from mobile phones for 30 days. All animal procedures were carried out in accordance with standard practice of the use of experimental animals. At the end of the experiment, animals were sacrificed and about 2 - 3ml of blood samples was received in a tube containing dipotassium ethylene diaminetetra acetate (EDTA).

Body Weight study

The body weights of the rats were taken weekly for a period of four weeks in order to detect any changes in them. A sensitive balance (OHAUS V11P15, USA) was used and weights were recorded to the nearest gram.

Haematological Parameters

Determination of haematological parameters was carried out using 18 automated parameter haematology analyzer, ABX Micros 60 from Horiba ABX, France.

Data Analysis

Data were analyzed using SPSS program (statistical package for social sciences Inc. Chicago, Illinois). Means were compared by independent-sample t-test. A difference was considered significant at probability $P \leq 0.05$.

Results and Discussion

Effect on Body Weight

The result showed that percentage change in weights of the exposed rats was lower than those that were not exposed (control) (Table 1). Weight of rats decreased with increase in duration of exposure compared with the control (0 hour). The lowest weight gain within the four weeks was recorded in the group exposed for 12 hours. Also, the exposed animals eat less as a result of fear and stress whenever the phone rang.

Effect on Haematological Indices

Table 2 shows the effect of different duration of exposure to electromagnetic radiation from mobile phone on the haematological indices of wistar albino rats. Data show that EMR from mobile phone caused a decrease in red blood cell, packed cell volume and mean corpuscular haemoglobin concentration as the duration of exposure increased from 4 hours to 12 hours compared with control. Also, white blood cell and haemoglobin reduced as the duration of exposure increased from 4 and 8 hours exposure but a sudden decrease was noticed in the 12 hours exposure. Lymphocyte, Neutrophil, Mean corpuscular haemoglobin (MCH) and Mean corpuscular volume (MCV) increased as the duration of exposure increased while mean corpuscular haemoglobin concentration (MCHC), basophil and eosinophil remained the same as the duration of exposure increased.

Table 1. Statistical data of the weights of rats over a period of four weeks

Week	Control	4 Hours	8 Hours	12 Hours
BEFORE EXPOSURE	118.80 ± 3.42	121.48 ± 9.53	120.78 ± 2.58	120.50 ± 9.59
1 ST WEEK (Grams)	126.27 ± 4.21	130.58 ± 7.89	129.21 ± 4.69	127.50 ± 8.54
2 ND WEEK (Grams)	133.50 ± 5.51	144.50 ± 8.49	140.23 ± 12.33	135.50 ± 5.71
3 RD WEEK (Grams)	152.30 ± 4.32	156.00 ± 11.89	148.13 ± 6.50	141.00 ± 13.12
4 TH WEEK	160.30 ± 5.51	162.00 ± 7.75	159.14 ± 3.42	156.90 ± 15.43
% Change in weight gain (Grams)	35.61 ± 0.25	33.36 ± 0.67	31.76 ± 0.55	30.21 ± 0.34

Table 2. Effect of duration of exposure to 900 MHz electromagnetic radiation from mobile phone on the haematological parameter rats

Parameters	Control N= 8	Group A (4 hours) N = 8	Group B (8 hours) N = 8	Group C (12 hours) N = 8
Packed Cell Volume (PCV) %	46.00 ± 2.30	44.75 ± 1.70	41.25 ± 1.00	41.00 ± 1.20
Red Blood Cell (RBC) 10 ⁶ Cell/ uL	14.99 ± 2.30	14.68 ± 1.20	13.61 ± 0.40	12.32 ± 0.60
White Blood Cell (WBC) 10 ³ Cell/uL	17.31 ± 3.00	20.55 ± 2.50	21.35 ± 1.43	19.11 ± 1.11
Haemoglobin (Hb) g/100ml	14.85 ± 0.79	14.68 ± 1.00	15.25 ± 0.72	14.08 ± 0.64
Mean Corpuscular Volume (fl)	33.14 ± 4.27	32.13 ± 2.90	30.69 ± 2.85	34.37 ± 0.94
Mean Corpuscular Heamoglobin Concentration (%)	33.37 ± 0.10	33.35 ± 0.10	33.33 ± 0.10	33.31 ± 0.10
Mean Corpuscular Heamoglobin (pg/dl)	10.09 ± 1.61	10.08 ± 1.34	11.20 ± 0.33	11.44 ± 0.42
Lymphocyte	67.00 ± 1.00	62.33 ± 0.63	61.67 ± 0.61	61.33 ± 0.64
Neutrophil	28.33 ± 2.10	26.33 ± 0.60	26.67 ± 0.60	29.67 ± 1.23
Monocyte	5.70 ± 0.59	8.00 ± 0.00	8.7 ± 0.59	8.7 ± 0.59
Eosinophil	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00
Basophil	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00	1.30 ± 0.00

Table 3. Showing the result of [12] on the effect of microwave radiation on blood indices

Parameters	Control	Experimental
White blood cell	15.313 ± 0.0610	19.163 ± 1.34
Red blood cells	9.6238 ± 0.0984	8.5375 ± 0.1156
Haemoglobin	12.3380 ± 0.1291	12.3800 ± 0.2556
Heamatocrit / PCV	39.461 ± 0.291	34.278 ± 7.33
Mean Corpuscular volume	51.425 ± 0.4296	46.356 0.311
Mean Corpuscular heamoglobin	17.1876 ± 0.106	14.246 ± 0.1395
Mean Corpuscular haemoglobin concentration	34.2438 ± 0.154	32.1975 ± 0.010

Discussion

The assessment of haematological parameters are very crucial to determine the detrimental effects of EMR generated by mobile phones in experimental animals.

It helps in monitoring and determining the consequences of the EMR induced hazardous alterations to humans. Findings of the study revealed that the weight gain of the exposed rats was lower than the rats that were not exposed. It was observed that the loss in weight could be as a result of stress and fear the

rats were subjected to whenever the phones rang. The result was in agreement with the result from related studies [1, 8] where body weight of rats decreased as a result of exposure to radiation from mobile phone. In addition, the levels of Haemoglobin and White blood cell increased as the time of exposure increased as a result of the lysing of the RBC cell wall to release free haemoglobin. This result was similar to the findings of [9, 12] and [13] where the haemoglobin and white blood cell also increased as the duration of exposure increased. The deviations from these previous studies were the significant decrease in HB and WBC in 12-hour exposure of the animals to the radiation, this could be as a result of production of free radicals that caused deleterious effects on the free haemoglobin, breaking it down and denaturing the protein (globin) during the course of oxidative stress. The change in white blood cell as exposure duration increased is an indication of anaemia. It is also an evidence of bleeding which arises as a result of exposure to radiation [14]. The depletion in red blood cells (RBC) and packed cell volume (PCV) of exposed animals may be due to inflammation and cellular proliferation, which became adverse as the time of exposure increased. Similar conditions may be found in anaemia and leukaemia. This could also leads to cell walls damage and imbalance in blood enzymes [12]. Similarly, MCH, MCV and MCHC are medically significant in the diagnosis of anaemia, similar outcome was reported in the study conducted by [8]. The increase in MCV and MCH is an indication of macrocytic anaemia [15]. Furthermore, the increase in lymphocytes, monocytes and neutrophil is associated with lymphatic leukaemia or inflammation of the lymph gland, which is a result of constant exposure to EMR from mobile phone [9].

Conclusions

Finally, the results from this study revealed that non-ionising radiation from mobile phone could reduce body weight and cause deleterious effect on the blood indices of exposed rats with increase in duration of exposure. Thus, potentially predisposing the animal to anaemia and opportunist infections.

Abbreviations

RF: Radiofrequency; NIR: Non-ionizing radiation; EMR: Electromagnetic radiation; RBC: Red blood cells; PCV: Packed cell volume.

Author Contributions

The author gave final approval for the publication of this study.

Competing Interests

The author has declared that no competing interest exists.

References

- [1] Usikalu, M. R., Rotimi, S. O., & Oguegbu, A. E. (2012). Effect of exposure of 900 MHz radiofrequency radiation on rat brain. *European Journal of Experimental Biology*, 2(6), 2499-2504.
- [2] Statista (2018). Forecast of mobile phone users worldwide. <https://www.statista.com/statistics/274774>
- [3] Hardell, L., & Carlberg, M. (2015). Mobile phone and cordless phone use and the risk for glioma—Analysis of pooled case-control studies in Sweden, 1997–2003 and 2007–2009. *Pathophysiology*, 22(1), 1-13.
- [4] Divan, H. A., Kheifets, L., Obel, C., & Olsen, J. (2008). Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology*, 523-529.
- [5] Fragopoulou, A. F., Samara, A., Antonelou, M. H., Xanthopoulou, A., Papadopoulou, A., Vougas, K., Koutsogiannopoulou, E., Anastasiadou, E., Stravopodis, D.J., Tsangaris, G.T. & Margaritis, L. H. (2012). Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. *Electromagnetic biology and medicine*, 31(4), 250-274.
- [6] Hardell, L., Carlberg, M., & Mild, K. H. (2009). Epidemiological evidence for an association between use of wireless phones and tumor diseases. *Pathophysiology*, 16(2-3), 113-122.
- [7] Roberts, N. J., Michaelson, S. M., & Lu, S. T. (1986). The biological effects of radiofrequency radiation: a critical review and recommendations. *International Journal of Radiation Biology and Related Studies in Physics, Chemistry and Medicine*, 50(3), 379-420.
- [8] Aziz, I. A., El-Khozondar, H. J., Shabat, M., Elwasife, K. A., Osman, M. (2010): Effect of Electromagnetic Field on Body Weight and Blood Indices in Albino Rats and the Therapeutic Action of Vitamin C or E. *Romanian Journal of Biophysics*, 20(3), 235-244.
- [9] Mariam S, A., & Nawal A, E. G. (2012). Effects of exposure to electromagnetic field on of some hematological parameters in mice. *Open Journal of Medicinal Chemistry*, 2012.
- [10] Verkasalo, P. K., Pukkala, E., Hongisto, M. Y., Valjus, J. E., Järvinen, P. J., Heikkilä, K. V., & Koskenvuo, M. (1993). Risk of cancer in Finnish children living close to power lines. *British medical journal*, 307(6909), 895-899.
- [11] Kleinerman, R. A., Kaune, W. T., Hatch, E. E., Wacholder, S., Linet, M. S., Robison, L. L., Niwa, S. & Tarone, R. E. (2000). Are children living near high-voltage power lines at increased risk of acute lymphoblastic leukemia? *American Journal of Epidemiology*, 151(5), 512-515.
- [12] Reddy, V. B. M. (2017). Biochemical Alterations as Markers of Mobile Phone Radiation in Mice. *Research Journal of Pharmaceutical Biological and Chemical Sciences*, 8(2), 1808-1815.
- [13] Hasan, H., & Issmer, A. (2014). Effect of emitted radiation from mobile phones and its base station antennas on some biochemical parameters in human red blood cells. *International Journal of Scientific & Engineering Research*, 5(3), 965-970.
- [14] Clark G (1988). "Staining Procedures," Lippincott Williams & Wilkins, Philadelphia.
- [15] Fatayer, A. (2006). Hematology (theoretical and practical) culture library house for publication and distribution. *Journal of Environmental Studies*, 2, 223-229.