Effects of Electromagnetic Radiation of Mobile Phones on Hematological and Biochemical Parameters in Male Albino Rats

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Abstract

The widespread usage of mobile phones in recent years has raised concern for potential dangers and subsequent research activities. Many have tried to determine the effects of the emitted electromagnetic radiation of mobile phones. The present study was aimed at evaluating the effects of EMR from mobile phones on behavior, some hematological (RBC, MCV, WBC, HGB, MCH, MCHC, LYM, LYM %) and biochemical parameters (AST, ALT and ALP) in experimental rats. The results indicated that there is increase in mean weight of animals exposed to low EMR but the increment was less as the exposure period increases. No changes were observed in terms of their behavior. The values of RBC, HGB and MCH in 100% of the experimental animals in all groups of low and high EMR have exceeded that of the control. However, the values of WBC in 100% of experimental animals have not exceeded that of the control group. The mean values of AST and ALT in 30% of high EMR exposed rats has exceeded the control groups. There is no significant difference between high and low EMR exposed rats in terms of hematological parameters (RBC, MCV, WBC, HGB, MCH, MCHC, LYM, LYM %) and biochemical parameters (ALT, AST and ALP) (P>0.05).

Keywords: Mobile phones; Electromagnetic radiation; Albino rats

Introduction

Mobile phones are one of the popular and fastest growing technological advancements. It has become necessary in our modern life. The widespread usage of mobile phones in recent years has raised concern for potential research activities [1]. Many countries have tried to determine the effect of the emitted electromagnetic radiation from mobile phones which over the last two decades has received a rapid growth in the number of people using mobile phones (MPHs). Humans are exposed to radiofrequency electromagnetic radiation emitted from mobile phones and this has created a need to investigate its possible ill effects on health of individuals [2,3]. There is a widespread concern in the society about the adverse effects of electromagnetic fields produced by mobile telephones and their base stations on human [4].

It has been revealed that exposure to various forms of radiation could lead to reversible or irreversible structural and functional changes at the cellular level. This damage depends on the frequency of the electromagnetic fields, electrical field applied, and intensity of the power and the duration of exposure [5,6].

The mobile phone emitting 900 MHz electromagnetic radiation (emr) may be mainly absorbed by kidneys because they are often carried in belt. Exposure to electromagnetic radiation (emr) emitted from mobile phones is able to induce hepatic, renal and splenic tissue damage. The degree of damage increased with time of exposure to EMR [7]. Radiofrequency of electromagnetic radiation from mobile phones also induces oxidative stress in rats.

Since their invention, the telephone has seen much technological advancement up to mobile phones. Various types of telephones are used in Kano and Nigeria in general. There are touchtone phones, wireless hand-sets, car-phones, and most recently the cell phone and smartphones have all emerged which are the most widely used recently. Innovations in cell phones may be associated with detrimental effects on various organs, systems and their functions [8,9]. As such, this research will help in providing sufficient data in addition to the existing ones in monitoring and regulating the extent of usage among population of Kano and Nigeria at large. In view of this, the study was aimed at evaluating the effects of EMR from mobile phones on behavior, some hematological and biochemical parameters in experimental rats.

Materials and Methods

Experimental design

Male albino rat (Rattus narvegicus) used for this experiment were obtained from Voom Research Institute in Jos, Plateau State and the study was conducted at Animal House of Deparrtment of Biological Sciences, Bayero University Kano. 21 male albino rats were used each of which weigh 90-120 g. The experimental animals were acclimatized for 7 days prior to the

study and were provided with water and ad libitium. The pie cage restrainer was made of ion each pie cage housed 8 to 10 rats and had litter at the bottom in order to reduce the stress in the restrainer air passage of 1cm in diameter were opened at the top of each cage and were fixed at room temperatura [10-12]. The rats were randomly divided into 7 groups, the first 3 groups were exposed to the same EMR emitted by low radioactive phone (Techno with frequency 900mHz with different time of exposure everyday for 28 days (4 weeks). Group was exposed for 1 hour per day, Group 2 was exposed for 3 hours per day, Group 3 was exposed for 5 hours per day.

Another 3 groups were exposed to electromagnetic radiation emitted by high radiative phone (Samsung Galaxy young with frequency 1.3 GHz) with different time of exposure everyday for 28 days (4 weeks). Similarly, 3 groups were exposed to the same EMR emitted by high radioactive phone (Samsung Galaxy Young with frequency 1.3 GHz) with different hours of exposure every day for 28 days (4 weeks). Group 4 was exposed for 1 hour per day, Group 5 was exposed for 3 hours per day, Group 6 was exposed for 5 hours per day. Mobile phone was placed on top of each cage during the hours of exposure [13]. The mobile phones were on with SIM cards inserted and after the hours of exposure the phones were removed.

The 7th group is the control group which was placed at the same time and kept in the pie cage restrainer away from the radiofrequency source but did not receive any treatment. The cage was free from all kinds of material which will affect electromagnetic field. All rats were cared in accordance with Good Laboratory Practice.

Changes in weight and hair loss

Weekly body weight: The weekly Body Weight (BW) of each animal was assessed using a sensitive electronic balance during the acclimatization period, once before commencement of dosing, once weekly during the exposure period and once on the day of sacrifice.

Mortality and clinical changes

During the 4-weeks exposure period, all the animals were observed daily for clinical signs and mortality once before dosing, immediately after dosing up to 3 h after dosing.

Laboratory analysis

After the experimental period (4 weeks) the animals were sacrificed. Blood samples were collected in an EDTA container to determine hematological parameters and gel vacutainer for biochemical parameters.

Hematological parameters: RBC, MCV, WBC, HGB, MCH, MCHC, LYM, LYM % were analyzed using Hematology analyser (Sysmex KX21N, Diamond diagnostic USA).

Biochemical analysis: The samples were centrifuged at 3000 revolution per minute and the serum was removed from whole blood. Aspartate Amino Transferase (AST) Alanine Amino

Transferase (ALT) and Alkaline Phosphatase (ALP) were analyzed using spectrophotometer carry 50 model number 0906 mo12.

Statistical analysis

T test was used to check for significant difference between two variables.

Results and Discussion

There is increase in mean weight of animals exposed to low EMR but the increment was less as the exposure period increases. Similarly, there is an increase in mean weight of animals in group exposed to 1hr high EMR but the mean weight of the subsequent groups exposed to 3hrs and 5hrs high EMR decreases below their initial mean weight [14]. There are no observable changes in the experimental animal's behavior (movement, orientation, interaction etc.) throughout the experimental period. The movement was freely and active. There is no significant difference between the initial weight and final weights of the exposed rats ($p>0.05$). Reduction in body weight of exposed mice (GII: VDU 8-10h/day for different time intervals i.e. 1 week, 2 weeks, 4 weeks, 6 weeks respectively) has been observed in present investigation as compared to control. It is reported to increase with increase in exposure time. Maximum reduction up to 33% in body weight of GII mice has been observed after 42 days of exposure, as compared to GI (normal control mice which will not be exposed to any source of radiations). Related observations were made by others. Persinger et al. studied that the rats exposed to 1–30 G at 0.5 Hz for 10-26 days showed progressive changes in the total body weight, thyroid weight and water consumption (**Table 1**). Similarly, Marino et al. have reported that mice exposed to low electric fields (150 V/cm) at 60 Hz for one month have reduced body weight and decreased water consumption [15,16].

Table 1: Mean of weight of Albino rats groups before and after exposure to EMR pones.

Groups	Initial weight (g)	Final weight (g)
1	120	130
2	105	110
3	95	100
4	100	110
5	103	90
6	106	80
7	100	140

In experimental animals exposed to low EMR, the result obtained showed that the values of RBC, MCV, HGB and LYM are fluctuating across the exposure period as seen in **Table 2**. The values of WBC, MCH and MCHC are decreasing across the exposure period. This was in agreement with the findings of

Diechmann et al. However, the value of LYM % is decreasing across the exposure period [17].

Table 2: Mean values of Hematological parameters in blood of rats exposed to low EMR pones.

Hours of exposure	RBC (×10⁶/µL)	MCV (fL/cell)	WBC (×10³/µL)	HGB (g/dL)	MCH (pg/cell)	MCHC (g/dL)	LYM (×10³/µL)	LYM (%)
1	5.45	57.3	9.4	12.5	22.9	40	7.1	75.7
3	6.03	54.8	7.3	13.1	21.7	39.7	5.7	78.1
5	5.73	62	7.3	12.2	21.4	34.5	6.5	88.9
Control	4.27	56.1	10.9	8.4	19.9	35.5	8.7	79.8

For animals exposed to high EMR as seen in **Table 3**, the value of RBC, MCV, HGB and LYM% are decreasing across the exposure period. In a study by Alghamdi & El-Ghazaly, they revealed that there is a significant reduction in the measurements of the blood, hemoglobin Hb and hematocrit Hct, in addition to other indices of red blood cells such as RBC, MCV, MCH and MCHC which were also noted when there is increase in time of exposure in short and long term experiments under the influence of the devices used in the research [18]. Singh et al. reported that the Total RBC count and HGB of exposed mice have decreased as compared to normal control mice.

Table 3: Mean values of Biochemical parameters in blood of rats exposed to high EMR pones.

Hours of Exposure	RBC (×10⁶/µL)	MCV (fL/cell)	WBC (×10³/µL)	HGB (g/dL)	MCH (pg/cell)	MCHC (g/dL)	LYM (×10³/µL)	LYM (%)
1	5.78	66.5	7.2	12	20.7	31.2	6.6	90.9
3	5.43	61.44	7.1	11.67	20.9	33.49	7.88	83.21
5	5.15	55.5	10.2	11.2	21.7	39.1	8.7	79.7
Control	4.27	56.1	10.9	8.4	19.9	35.5	8.7	79.8

This decline is an indication of different types of anemia, as well as leukemia. Al-shaer et al. also reported that the total red blood cell count and hemoglobin content of exposed rats has been observed to decrease as compared to normal control rats after 42 days of exposure.

However, WBC, MCH, MCHC and LYM are increasing across the period. Alghamdi & El-Ghazaly observed a significant increase in the average number of white blood cells WBC as well as the proportion of lymphocytes LYM and this increase might be accompanied with cases of anemia [19]. This may arise under the influence of exposure to radiation, increased temperature and body resistance.

Similarly, the values of RBC, HGB and MCH in 100% of the experimental animals in all groups of low and high EMR have exceeded that of the control. However, EMR exposure resulted in significant decreased (P ≤ 0.001) in HGB, monocytes, RBC and MCHC. Similarly, Lysina reported no significant difference in the circulating erythrocyte count of 100 workers exposed to super high frequency (SHF) field but gave no information about frequency intensity, or duration of exposure. The values of MCV, MCHC and %LYM in 50% of experimental animals have exceeded that of the control. The increase in the %LYM may be associated with lymphatic leukemia or inflammation of the lymph gland which will appear as a result of constant exposure to electromagnetic waves [20-22]. Diechmann et al. reported significant leukocytosis, lymphocytosis and neutrophila in rats following seven hours exposure to 24,000 mHz. One week after exposure, the peripheral blood value returned to normal. However, the values of WBC in 100% of experimental animals have not exceeded that of the control group. Furthermore, the values of LYM in 100% of experimental animals have not exceeded that of the control. However, WBC, LYM, ESR and MCV increased significantly (P ≤ 0.001) in EMR exposed in mice compared to the normal control. Lysina observed slight increase in reticulocyte counts in exposed personnel but no change in leukocyte counts.

Consequently, it is apparent that partial or whole body exposure to EMR may lead to variety of changes in their hematological system. These changes are often transient, with blood counts or other response returning to normal either immediately or soon after the exposure. Interpretation of EMR effect on blood and blood forming systems depends to a great degree on the absorption of biological material and thermoregulatory system of the irradiated individual [23,24]. For example, blood, blood fluids, skin, muscle, brain and internal organs that contain large amount of water content as bone, fat and tendon.

T test indicated that there is no significant difference between low & high EMR exposed rats in terms of RBC, MCV, WBC, HGB, MCH, MCHC, LYM and LYM% (P>0.05).

ALT and AST as reported are specific liver enzymes that increase in hepatic diseases and toxic damage of liver cells

increased AST levels can occur in connection with damages of heart or skeletal muscle as well as liver parenchyma.

The mean values of ALP and ALT are fluctuating across the exposure periods in low EMR exposed rats. However, the values of AST are increasing from 1hr to 3hrs exposed rats but then it remains the same with 5hrs exposed rats (**Table 4**) [25].

Table 4: Mean values of biochemical parameters in blood of rats exposed to low EMR phones.

Hours of exposure	ALP (U/L)	AST (U/L)	ALT (U/L)
1	32.94	13	52
3	76.96	27	62
5	50.76	27	52
Control	63.37	19	57

The mean values of ALP and AST are fluctuating across the exposure periods in high EMR exposed rats. However, the values of ALT are increasing across the exposure periods from 1hr to 3hrs to 5hrs (**Table 5**).

Table 5: Mean values of biochemical parameters in blood of rats exposed to high EMR pones.

Hours of exposure	ALP (U/L)	AST (U/L)	ALT (U/L)
1	15.44	16	48
3	63.69	31	52
5	22.94	10	62
Control	63.37	19	57

The mean values of ALP in 100% of low EMR exposed rats have not exceeded the control group. Furthermore, the mean values of AST and ALT in 70% and 30% respectively of low EMR exposed rats have not exceeded the control groups. Similarly, In study by Ismail Abdel Aziz et al. Serum transaminases (AST & ALT), ALP and bilirubin exhibited a general increase in cases exposed to E.M.F compared to the controls. The observed elevation of serum AST, ALT and ALP activates in response to E.M.F exposure is in agreement with the study of Fatma et al., who observed the increases of liver enzyme activates ALT, AST and ALP in serum and liver tissue significantly and increased oxidative stress marks (MDA & H_2O_2) after exposure to mobile phone radiation in the liver of male rats. Bilirubin is a naturally occurring antioxidant of physiological importance and as such, could have a role in protecting lipid and lipoproteins against oxidation [26,27].

The mean values of ALP in 30% of high EMR exposed rats have not exceeded the control group. However, the mean values of AST and ALT in 30% of high EMR exposed rats has exceeded the control groups. Sharma et. al. found out that the values of ALT and AST levels in rats exposed to EMR were significantly higher than the control ($p \leq 0.05$).

There is no significant difference between high and low EMR exposed rats in terms of ALT, AST and ALP ($P>0.05$).

Conclusion

It can be concluded that there is no change in terms of behavior after exposure but there is increase in weight of animals which is seen to be affected by increase in exposure period. Among the hematological parameters, the values of RBC, HGB and MCH were observed to be higher in animals exposed to EMR. The values of biochemical parameters showed less increase in animals exposed to EMR than control group. Thus, indicating that long time exposure might pose detrimental effects to blood components, liver and their functions.

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