Journal of Blood Research & Hematologic Diseases

Research Article A SCITECHNOL JOURNAL

Studies on the Effect of 2.45 GHz Microwave Radiation on Heamatological, Body Weight and Food Intake Changes in Wistar Rats

Parul Chauhan*

Department of Biochemistry, Jaipur National University, Jaipur, Rajasthan, India

***Corresponding author:** Department of Biochemistry, Jaipur National University, Jaipur, Rajasthan, India, Tel: 9887865720; E-mail: chauhanparul51@gmail.com

Received date: 11 August, 2023, Manuscript No. JBRHD-23-110212;

Editor assigned date: 14 August, 2023, PreQC No. JBRHD-23-110212 (PQ);

Reviewed date: 28 August, 2023, QC No. JBRHD-23-110212;

Revised date: 14 May, 2024, Manuscript No. JBRHD-23-110212 (R);

Published date: 21 May, 2024, DOI: 10.4172/jbrhd.1000203

Abstract

The present study is an attempt to study the effect of 2.45 GHz microwave IR radiation on wistar rats. Sixty days old Wistar rats exposed with 180 ± 20 g. Body weights were selected for this study. Animals were exposed to 2.45 GHz microwave with the power density of 0.2 mW/cm^2 and specific absorption rate was estimated 0.14 W/kg, daily for 2 hr/day for 35 days. For this purpose (2 month old) selected for this study. Group 1 (Sham exposed) animals of this group served as control as they were placed in plexi glass cage without energizing the system for 2 h/day for 35 days. Group 2 (exposed) animals of this group served as exposure as they were placed in plexi glass cage under microwave 2.45 GHz for 2 h/days for 35 days. So the result of this study is show that microwave radiations change the heamatological parameters as well as body weight and food intake capacity.

Keywords: Microwave; Radiation; Plexi glass; Heamatological parameters; Body weights

Introduction

Previous studies on radiations have shown an adverse effect on human health and other biological disturbance on cells. As we know that technology based on RF/MW has been increasing since past decades. The living society of today's world is much more based on these technologies that increase much more concern about the effects of RF/MW. There are many daily using appliances e.g. microwave, mobiles phones, wireless devices etc. Normally, cell phones emit the Microwaves (MW), effect the biological systems mainly increasing free radicals, which may enhances lipid per oxidation and changing the activities of brain, liver and sperm cells. Electromagnetic energy is used in many forms and numerous population, industrial techniques and applications used some variety of these energy. Electromagnetic energy that is of increasing importance worldwide is Radiofrequency (RF) energy, including radio waves and microwaves, which are used for providing telecommunications, broadcast and other services.

As we know that electromagnetic Radiation Microwaves (MR) are non-thermal, non-ionizing EMR in nature, easily cause atomic excitation, molecular vibration and rotation, heat production [1]. When MWs interact with cell system of living organism, they produce the change *viz.* cell damage, enzyme inactivation, lipid per oxidation, DNA single strand break and double strand break oxidative stress [2-6]. The exposures of these radiations have been associated with changes in the Electrocardiogram (ECG) and Electromyogram (EMG), increased in peripheral vascular resistance and hypertension. Kesari and Behari, has also reported the point that exposure of MW at 2.45 GHz decrease sperm count, increase apoptosis and affects the level of antioxidant enzyme [7]. Microwave radiation when exposed, affect the kinetics of conformational changes of proteins, which caused may be free radical [8].

The present studies summarized the public issue based on mobile phone radiation exposure and their biological effects. This concludes that the regular and long term use of microwave devices (mobile phone, microwave oven) at domestic level can have negative impact upon biological system especially on brain. It also suggests that increased reactive oxygen species play an important role by enhancing the effects of radiation may cause infertility as well as neurodegenerative diseases. Present time the exponential rate of wireless communication increasing and raise a serious concern about the possible effects of Microwave (MW) on human health.

The growth of plants and microorganisms can also affect like animals through the electromagnetic irradiation [9]. Basic cellular functions can also be affected through the EMF. These effects include cell proliferation the cell cycle, protein synthesis, gene transcription and expression, neurite outgrowth and tissue damage in different organs of the experimental animals [10-15]. In the biological processes hemoglobin and other enzyme play a vital role; and also cell communication is facilitated by these biocatalysts. If alteration found in the activity of these enzymes may affect their functions. Usually public tend to use phone closer to lower abdomen near liver and kidney hence liver and kidney test are necessary. So the aim of the present work is to investigate the changes in liver and kidney as well as the whole blood.

Materials and Methods

Animal exposure

Sixty-day-old male Wistar rats (200 ± 10 g) were obtained from the animal facility of Jaipur National University, Jagatpura, Jaipur, Rajasthan. The animals were maintained at 25°C–27°C, constant humidity (40–50%) as per guidelines and protocols, approved by the Institutional Animal Ethics Committee. The animals were housed in clean polypropylene cages and maintained in a controlled temperature with constant 12 h light and 12 h dark schedule. The animals were fed on standardized normal diet (Tetragon Cheime Private Limited, Bangalore) and water ad libitum. A quantitative measurement of feeding and animal weight was also recorded on daily basis.

Exposure chamber

Rats were placed in a Plexiglas cage ventilated with holes of 1 cm diameter. The dimension of each house in exposure cage was identical and made in such a way that animals are comfortably placed. The

exposure cage with two animals was kept in an anechoic chamber in a far field region from the horn antenna. In the exposure chamber, all the animals were facing horn antenna with in consideration that no animals blocked the radiations falling on any other. Animals were divided into two groups: Sham exposed and 2.45 GHz Microwave (MWs) exposed. All the experiments were repeated.

Anechoic chamber is lined with radar absorbing material (attenuation, 40 db) to minimize the reflection of scattered beam. Rats were exposed to 2.45 GHz radiations source at 50 Hz modulation frequency (input, 1,080 W; output, 700 W). Microwave oven was used as a source of exposure, connected to 40 db attenuation and to the horn antenna. The temperature in the chamber was maintained around 25°C-27°C throughout the experiment. Exposure was given for 2 h a day for 35 days at 0.21 mW/cm^2 power density. The whole body Specific Absorption Rate (SAR) was estimated to be 0.14 W/kg. The emitted power of microwaves was measured by a power meter (Model-U2000 series USB power sensors), which is a peak sensitive device (power sensor). Every day, the cage was placed in the same position facing the horn antenna, and the same numbers of rat positions were reshuffled. Similar experiment was performed with sham exposed animals without energizing the system.

Collection of blood sample

In the 20^{th} and 35^{th} days of exposure, each animal was anaesthetized with ether and then blood sample were collected by heparin coated capillary tubes from the retro orbital sinus of eye vein in the heparin coated tubes. The sample was further send for examination to a lab where Coulter diff Act Tainer reagent pack or diff Act Pak, both of which contain diluents (reagent 1) and lytic reagent (reagent 2). The diff Act Tainer reagent pack also contains Act rinse shutdown diluent (reagent 3) was used to determining the results.

Results

MW exposed result in a significant decrease ($p<0.01$) in blood volume, RBC, hemoglobin level as compared to sham rats in first observation (20^{th} day). However MW exposed results witness a significant increase ($p<0.01$) in WBC, platelets, total protein, glucose, creatinine, ALT level as compared to sham in first observation (20^{th} day). As we looked forward for 35^{th} day observation, MW exposed result in a continuous significant decrease ($p<0.01$) in blood volume, RBC and albumin. Moreover MW exposed results witness a significant increase ($p<0.01$) in WBC, platelets, ALT as compared to sham exposed results (Tables 1-4).

Experiments	Units	Sham exposed	2.45 GHz exposed
Blood volume	ml/100 g	7.33 ± 0.08	6.28 ± 0.06**
RBC	$10^6/mm^3$	8.21 ± 0.05	6.83 ± 0.27**
PCV	%	37.5	36.2
WBC	$10^6/mm^3$	13.4 ± 0.05	13.94 ± 0.54**
Hemoglobin	g/dL	12.46 ± 0.06	11.5 ± 0.03**
Neutrophills	$10^3/mm^3$	1.87 ± 0.053	2.36 ± 0.29
Lymphocytes	$10^3/mm^3$	6.88 ± 0.053	6.12 ± 0.95
Eosinophils	$10^3/mm^3$	0.35 ± 0.002	0.42 ± 0.01***
Monocytes	$10^3/mm^3$	0.013 ± 0.002	0.03 ± 0.0003**
Basophills	$10^3/mm^3$	0.023 ± 0.002	0.002 ± 0.0004**
Platelets	$10^3/mL$	167.45 ± 3.186	349.5 ± 7.94**
Total protein	g/dL	5.13 ± 0.06	6.13 ± 0.10**
Albumin	g/dL	4.88 ± 2.31	4.57 ± 0.21
Glucose	mg/dL	55.11 ± 2.176	93.16 ± 3.1**
BUN	mg/dL	15.76 ± 0.08	16.83 ± 0.34**
Creatinine	mg/dL	0.21 ± 0.04	0.43 ± 0.05**
ALT	U/L	17.87 ± 0.35	25.01 ± 1.13**
AST	U/L	45.79 ± 0.05	48.08 ± 1.05
Total bilirubin	mg/dL	0.16 ± 0.04	0.28 ± 0.10***
Amylase	SU/dL	130 ± 0.6	223.75 ± 35.76

Note: (All values are expressed as mean ± S.D Significance levels: *= highly significant differences at $p<0.001$, **= significant differences at $p<0.01$, ***= non-significant differences at $p<0.05$. Statistical comparison: Sham exposed *vs.* MW exposed.)

Table 1: Results of complete blood count and liver kidney test of 20^{th} day.

Experiments	Units	Sham exposed	2.45 GHz exposed
Blood volume	ml/100 g	7.45 ± 0.059	6.49 ± 0.022**
RBC	$10^6/mm^2$	8.08 ± 0.054	6.875 ± 0.52
WBC	$10^6/mm^3$	13.95 ± 0.056	14.24 ± 1.2***
PCV	%	36	37
Hemoglobin	g/dL	11.89 ± 0.081	10.95 ± 0.8
Neutrophills	$10^3/mm^3$	1.99 ± 0.081	2.45 ± 0.28**
Lymphocytes	$10^3/mm^3$	6.78 ± 0.07	6.54 ± 0.53***
Eosinophills	$10^3/mm^3$	0.30 ± 0.25	0.024 ± 0.001***
Monocytes	$10^3/mm^3$	0.0024 ± 0.00054	0.002 ± 0.0005***
Basophills	$10^3/mm^3$	0.029 ± .0052	0.014 ± 0.0027**
Platelets	$10^3/mL$	178.08 ± 2.05	263.91 ± 10.77**
Total protein	g/dL	5.21 ± 0.064	5.46 ± 0.18***
Albumin	g/dL	4.07 ± 0.055	3.27 ± 0.35**
Glucose	mg/dL	58.08 ± 1.03	75.331 ± 6.94***
BUN	mg/dL	15.52 ± 0.3	16.84 ± 0.46***
Creatinine	mg/dL	0.32 ± 0.06	0.3 ± 0.05***
ALT	U/L	18.28 ± 0.72	21.91 ± 0.95**
AST	U/L	45.62 ± 0.24	46.6 ± 0.42***
Total bilirubin	mg/dl	0.028 ± 0.005	0.024 ± 0.001
Amylase	SU/dL	141.53 ± 4.167	255.73 ± 20.175***

Note: (All values are expressed as mean ± S.D Significance levels: *= highly significant differences at p<0.001, **= significant differences at p<0.01, ***= non-significant differences at p<0.05

Statistical comparison: Sham exposed *vs.* MW exposed.)

Table 2: Results of complete blood count and liver kidney test of 35th day.

Days	Exposed	Control
1	65.5	70
20	34.25	96.5
35	27.75	97.75

Table 3: Food intake capacity of animals (in gram).

Days	Exposed	Control
1	80.75	54
20	75.75	57.75
35	75.5	58.5

Table 4: Weight list of animal (in gram).

Discussion

Studies of blood parameters are the most important factors to analysis health of samples (animals, human etc.). Talking about living object coming into contact with RF radiation, blood and blood parameters would be primary particles. In blood, ions are directly reactive to the RF radiations.

According to Sisodia et al. diminution in values of blood parameters, may be high dose of radiation (lethal dose) that form direct damage in heamatological parameters or most of the time, due to MW interaction, which produce ROS in a beyond the level [16]. Due to MW interaction, formation of high ROS level and final product formed as free radical. These free radicals change the properties of blood parameters.

Results of present study (in 35th day) agreed with the study of Zsolt et al. noted that value of PCV increased after 2 hrs/day for 2 week [17]. Our findings agree with the Aziz et al., who reported that significant increase in some blood parameters WBC, blood platelets and significant decrease in RBC, HB in radio frequency exposed animals as compared to sham exposed [18]. Some of parameters in our study decrease in total RBC count, PCV% and HB concentration as well as with the significant increase in total WBC are in agreement with the investigation of Hassan, reported that these changes caused by the radiofrequency microwave in female rats [19].

Others results in our study relevant with the Amara, et al. who reported significant increase in WBC, PCV% (35th days), but some parameters are contradictory to these authors in case of RBC, they evaluate that action of SMF on the geometrical conformation of HB was reinforced by the fact that Static Magnetic Field (SMF) induced a prominent effect on HB structure [20].

Our studies showed a significant increase in blood parameters *viz.* ALT and AST (in both 20th and 35th days) in increase duration of MW radiation exposure. According to Pashovkina, et al. if the level of ALT and AST enzyme increased, that is a signal of hepatic disease and toxic damage of liver because these enzymes are specific for liver [21].

Research of Novokov, et al. who investigate that, if the value of total bilirubin and total protein raised, they indicate the results from the damaged cells which leak into circulation after exposure to magnetic field and this study similar to our findings [22].

The present study reported, completely support the study of Oktem, et al. showed the kidney function test such as creatinine were significantly increased in MW radiation exposure, compare to control one [23].

Conclusion

As seen the present study the body weight of the exposed as well as normal sample almost remain unchanged during the experiment duration. But there was a drastic increase in the food intake of exposed samples as compared to normal samples and as per their earlier consumption also.

References

1. Aweda MA (2000) Photophysical processes in the clinical applications of non-ionizing radiation. J Med Rehabil Ther 5: 15-19.
2. Cleary SF (1990) Biological effects of radiofrequency electromagnetic fields. In: Gandhi OP, editor, Biological effects and medical applications of electromagnetic energy. 236-255.
3. Behari J, Paulraj R (2007) Biomarkers of induced electromagnetic field and cancer. Indian J Exp Biol 45: 77-85.
4. Paulraj R, Behari J (2006) Single strand DNA breaks in rat brain cells exposed to microwave radiation. Mutat Res 596: 76-80.
5. Kesari KK, Behari J (2009) Fifty-gigahertz microwave exposure effect of radiation on rat brain. Appl Biochem Biotechnol 158: 126-139.
6. Aweda MA, Usikalu MR, Awobajo FO (2011) Effect of exposure to 2.45 GHz microwave radiation on male rat reproductive system. Int J Curr Res 2: 120.
7. Kesari KK, Behari J (2009) Effect of microwave at 2.45 GHz radiations on reproductive system of male rats. Toxicol Environ Chem
8. Bohr H, Bohr J (2000) Microwave enhanced kinetics observed in ORD studies of protein. Bioelectromagnetics 21: 68-72.
9. Tadevosian A, Kalantarian V, Trchunian A (2007). The effect of electromagnetic radiation of extremely high frequency and low intensity on the growth rate of bacteria *Escherichia coli* and the role of medium pH. Biofizika 52: 893-898.
10. Zhang M, Li X, Bai L, Uchida K, Bai W, et al. (2013) Effects of low frequency electromagnetic field on proliferation of human epidermal stem cells: An *in vitro* study. Bioelectromagnetics 34: 74-80.
11. Gerner C, Haudek V, Schandl U, Gundacker N, Hutter HP, et al. (2010) Increased protein synthesis by cells exposed to a 1,800 MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling. Int Arch Occup Environ Health 83: 691-702.
12. McFarlane EH, Dawe GS, Marks M, Campbell IC (2000) Changes in neurite outgrowth but not in cell division induced by low EMF exposure: Influence of field strength and culture conditions on responses in rat PC12 pheochromocytoma cells. Bioelectrochemistry 52: 23-28.
13. Zhao R, Zhang S, Xu Z, Ju Li, Lu D, et al. (2007) Studying gene expression profile of rat exposed to 1800 MHz radiofrequency electromagnetic fields with cDNA microassay. Toxicology 235: 167-175.
14. Zare S, Alivandi S, Ebadi AG (2007) Histological studies of the low frequency electromagnetic fields effect on liver, testes and kidney in guinea pig. World Appl Sci J 2: 509-511.
15. Khayyat LI, Abou-Zaid D (2009) The effect of isothermal non-ionizing electromagnetic field on the liver of mice. Egypt J Exp Biol (Zool) 5: 93-99.

16. Sisodia R, Rifat F, Sharma A, Srivastava P, Sharma KV (2013) Effects of 10 GHz on hematological parameters in Swiss albino mice and its modulation by *Prunus avium*. J Environ Pathol Toxicol Oncol 32: 1-13.
17. Zsolt F, Somosy Z, Kubinyi G, Bakos J, Hudak A, et al. (2006) Effect of whole body 1800 MHz GSM-like microwave exposure on testicular steroidogenesis and histology in mice. Reprod Toxicol 22: 111-117.
18. Aziz A, El- Khozondar HJ, Shabat M, Elwasife K, Mohamed-Osman A (2010) Effect of electromagnetic field on body weight and blood indices in albino rats and the therapeutic action of vitamin C or E. Rom J Biophys 20: 235-244.
19. Hassan BF (2011) Subchronical effects of electromagnetic field exposure of adult female rats on some hormonal, biochemical and hematological parameters. DASJ 3: 47-53.
20. Amara S, Abdelmelek H, Salem MB, Abidi R, Sakly M (2006) Effects of static magnetic field exposure on hematological and biochemical parameters in rats. Braz Arch Biol Technol 49: 889-895.
21. Pashovkina MS, Akoev IG (2001) The liver enzymes which increase in hepatic diseases and toxic damage of liver cells. Biol Radioecol 41: 62–68.
22. Novikov VV, Kuvichkin VV, Fesenko EE (1999) Effect of weak combined low frequency constant and alternative magnetic fields on intrinsic fluorescence of proteins in aqueous solutions. Biofizika 44: 224–230.
23. Oktem F, Ozguner F, Mollaoglu H, Koyu A, UZ E (2005) Oxidative damage in the kidney induced by 900 MHz emitted mobile phone: Protection by Melatonin. Arch Med Res 36: 350–355.