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Biochemical Alterations as Markers of Mobile Phone Radiation in Mice.

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ABSTRACT

Cellular phone and mobile phone digital technology innovations are one of the most successful inventions of the twentieth century. At present, mobile became an intrinsic part of day to day life of human beings. Mobile phones emit microwave radiation and is ubiquitous in biological domain. The main sources for emission of microwave radiations are cell towers and mobile phones. The deleterious alterations of microwave radiations are still unknown, and there is lacuna on microwave radiation induced alteration in humans. The study was aimed to investigate the mobile phone microwave radiotin induced biochemical alterations in mice. Forty mice were divided into two groups, consisting of 20 animals in each group. The animals of experimental group were exposed to MWR continuously by using smart phones situated at centre of the polycarbonate cages. Haematological and biochemical parameters of mice exposed to mobile radiation for a period of 30 days. The levels of White Blood Cells (WBC) increased significantly ($P<0.0001$) as a result of MWR from Mobile phones. Creatinine, and Blood urea nitrogen increased significantly in experimental animals, this indicates that kidneys absorb the mobile radiation and alters the levels of urea and creatinine, which may emit approximately 900-MHz electromagnetic radiation. The findings revealed and evidenced that the mobile radiation is harmful effects on enzyme activity and tissue. The negative effects of MWR on human health is due to hypothermia and free radical that increase oxidative stress and cause damage to internal body organs.

Keywords: Biochemical alterations, Markers, Microwave radiation, Non-Ionizing Radiation, and Mice.

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INTRODUCTION

Mobile phones and mobile technology has imperative influence on lifestyle of human beings. Mobile became an intrinsic part of day to day life. Concomitant harmful implications which are emission due to extensive use of cellular phones made an alarm to the researchers, techies and biologists. Due to the influx of the mobile technology and its non-ionizing radiation on human health implications are often overlooked [1, 2]. Cell phone metamorphosis may be associated with inimical toxicological alterations on male reproduction, mammalian brain and even cardiovascular system. Non- Ionizing Radiation (NIR) is ubiquitous in human environment. The sources of NIR are mobile phones and cellular towers mainly emits Microwave Radiation (MWR), which emit radiofrequency electromagnetic waves (RF-EMW). The adverse effects of RF-EMF have been unknown yet [3, 4].

Transmit information of telephony technologies encoded into electromagnetic waves ranged between 900 MHz and 1800 MHz. To measure the impact of these RF-EMF on human body was established through a standardized unit called the Specific Absorption Rate (SAR) expressed as wtt/Kg. In all four bands, device specific SAR tests are carried out at the highest power level [4, 5]. While a person speaking into a cell phone, the sound waves from speaker goes through a transmitter that converts the sound into a sine wave. Our body vulnerably act as antenna that absorption later metamorphic to alternating cross-current. This phenomenon may alter the normal body functions, various studies have been reported on architectural alterations on body tissues after the radiation exposure [6,7].

Baharara (2008) reported that the effect electromagnetic fields on liver and spleen mononuclear cells of mouse embryo, found significant alterations in Kupffer cells of liver and lymphocytes of the spleen. A significant increase has been observed in dividing cells 8. In contrary, findings have been reported that the RF-EMR from cellular phones, Wi-Fi, microwaves affected negatively on general health even they did not notice any abnormal alterations [7].

Electromagnetic waves show significant increase in free radicals in mammals. This phenomenon causes irreversible and uncontrollable problems. Mobile communication technology is new technology, yet to elucidate and understand the long term biological modifications of electromagnetic fields [8]. The study was aimed to investigate and elucidate the possible effects of microwave radiation on components of serum and to determine the enzyme activity for long term toxicological effects in experimental animals. oxidative stress as a possible pathogenetic mechanism for harmful effects of long-term exposure.

It is predominantly contemplated that humans are immune to harmful implications of radiation by the Global System for Mobile Communication (GSM), since it is presuming that potency is too far low to cause deleterious degree of the body tissues by heating, as quantified through the SAR. The general perception that vulnerable adverse effects will arise only from extensive heating of body cells or tissues of human due to radiations.

However, the currently using low intensity, pulsed microwave radiation in GSM morphogenic technology can exert subtle, non-thermal alterations on the mammalian organism. This kind of alterations are repercussion of heterogeneity of oscillatory electrical biological hives in human cells and organisms and each of them characterized by a distinct frequency, some of which to be slam to those used in GSM technology.

Since, last three decade's abundant experimental affirmation has been reported on non-thermal eminences of MWR on living systems. Invitro studies divulged that an increase in epileptic activity in rats [9]. An increased permeability or erythrocytes and hemolization [10]. Calcium ion efflux increased [11]. Diminish in coherence of lymphocyte cytotoxicity, increased chromosomal aberrations and micronuclei in blood lymphocytes of human [12]. Synergistic impact with phorbol ester, a cancer promoting drug [13]. Architectural impairment of male reproductive system was reported [14].

In vivo affirmations of non-thermal influences, predominantly from experimental animals beneath GSM phone radiation. Enhanced DNA single and double strand breaks, embryo mortality, porosity of the blood in brain, epileptiform activity, and micronuclei formation in tissues of brain and liver in rats under exposition to radiation [15]. Early influences are negligible and they may have expressed as genetic damage, endocrine disturbances, histopathological damages [15, 16].

Nevertheless, there is a lacuna and inadequate research data on long-term concomitant alterations of MWR on histopathological alterations of hepatocytes, brain tissue and potency of oxidative stress. Children, infants and young adults are disproportionately impacted by endocrine, oxidative environmental disruptors, encompassing mobile phone radiation. Mobile phones when used by children According to the International Agency for the Research on cancer, radiofrequency energy deposition is two more in brain and ten times higher in bone marrow of the skull when compared with adult users [17].

However, studies have been demonstrated the electromagnetic mobile phone waves induced alterations on central nervous system [18, 19]. Brain EEG reports of rat exposed to electromagnetic waves brain shown that the alterations of the olfactory cortex, limbic and, subcortical parts^{6,7}, also enhanced cortex nerve stimulation [20, 21, 22, 23].

MATERIALS AND METHODS

Mice were divided into two groups, consisting of 20 animals in each group. The animals of both groups were allowed *ad libitum* access to tap water normal pellet feed. Both control and experimental group were maintained collectively in polycarbonate cages 30x40x40cm (W x L x H). The animal house was maintained at 27°C- 32°C with 45±5 humidity and Light dark cycle 12–12-hours cycle. The body weights of mice were recorded at the initiation and termination of the experiment. The mice were sacrificed by cervical dislocation on the day of experiment. The animals of experimental group were exposed to MWR continuously by using smart phones situated at centre of the polycarbonate cages. While experimentation cages were covered with the aluminium sheets to ensure the radiation on animals. Experimental animals were received the radiation by calling mode of the GSM cellular technology. Animals were exposed to mobile radiation 10 times per day with 10 minutes duration each time.

From the animals blood was collected by cardiac puncture and serum was separated by centrifugation at 2000 rpm for 15 minutes and storage at -20°C.

Haematological and biochemical parameters were analysed by using commercially available kits. Measured variables included red blood cell (RBC) count, white blood cell (WBC) count, haemoglobin (Hb) and packed cell volume (PCV) by [24]. Mean corpuscular volume (MCV) was measured by [25]. Glucose by [26], total proteins by [27].

The experimental data was tabulated and statistically evaluated by ANOVA with the help of SPSS version 22.0 package.

RESULTS AND DISCUSSION

The findings of the study were tabulated in table 1. It represents haematological and biochemical parameters of mice exposed to mobile radiation over a period of 30 days. The levels of White Blood Cells (WBC) increased significantly ($P < 0.0001$) as a result of MWV from Mobile phones. It indicates that the MWR triggers inflammation in exposed animals. Red blood cells declined significantly in experimental animals when compared with control groups. The depletion in red blood cells may be due to inflammation, similar conditions may find in anaemia. The haemoglobin percentages of experimental and control groups were not affected significantly, whereas as the activity levels of Haematocrit, Mean Corpuscular Volume, Mean Corpuscular Haemoglobin, Mean Corpuscular Haemoglobin Concentration, Platelet count were depleted significant ($P < 0.0001$) when compared with their respective control group.

These depletions clearly revealed that the electromagnetic waves alter the cell walls. The levels of Aspartate aminotransferase, Alanine aminotransferase, Alkaline phosphatase Acid Phosphatase were enhanced significantly in the experimental groups, increased alterations of these enzymes evidenced that MWR induces detrimental alterations in hepatic tissues. significantly depleted levels of α - Amylase, β - Galactosidase, High density lipoproteins were observed. It indicates the MWR induced imbalance in lipid metabolism and alterations in homeostasis of lipid metabolism.

Creatine phosphokinase levels enhanced significantly in experimental animals, it indicates the damage and oxidative stress to muscle tissue, the brain and the heart. Significant decreased levels of albumin and total proteins indicates that the MWR induces architectural damages to the liver even leads to hypoalbuminemia.

Creatinine, and Blood urea nitrogen increased significantly in experimental animals, this indicates that kidneys absorb the mobile radiation and alters the levels of urea and creatinine, which may emit approximately 900-MHz electromagnetic radiation.

Table.1: Mobile phone microwave radiation induced alterations on blood biochemical parameters in mice.

| Parameter | Control | Experimental | ANOVA t- test |
|--|----------------|----------------|-------------------------|
| White blood cells | 1.5313±0.0610 | 1.9163±1.34 | P< 0.0001 t = 14.882 |
| Red blood cells | 9.6238±0.0984 | 8.5375±0.1156 | P< 0.0001 t =20.23 |
| Haemoglobin | 12.3380±0.1291 | 12.3800±0.2556 | P < 0.663 t= 0.444 |
| Haematocrit | 39.461±0.291 | 34.278±7.33 | P < 0.05 t= 1.996 |
| Mean Corpuscular Volume | 51.4250±0.4296 | 46.356±0.311 | P <0.0001 t= 27.029 |
| Mean Corpuscular Haemoglobin | 17.1876±0.106 | 14.246±0.1395 | P <0.0001 t= 47.377 |
| Mean Corpuscular Haemoglobin Concentration | 34.2438±0.154 | 32.1975±0.010 | P <0.0001 t=30.789 |
| Platelet count | 656.0138±0.436 | 542.682±0.393 | P <0.0001 t=545.200 |
| Aspartate aminotransferase | 267.645±1.008 | 292.289±0.598 | P <0.0001 t=54.623 |
| Alanine aminotransferase | 47.207±0.106 | 53.534±0.337 | P <0.0001 t=50.607 |
| Alkaline phosphatase | 316.271±0.102 | 348.388±0.3200 | P< 0.0001 t=40.632 |
| Acid phosphatase | 2.426±0.209 | 9.272±0.143 | P<0.0001 76.182 |
| α- Amylase | 85.316±0.155 | 63.392±0.324 | P<0.0001 t=17.256 |
| β- Galactosidase | 23.206±0.63 | 18.297±0.194 | P<0.0001 t=47.307 |
| High density lipoproteins | 48.882±0.540 | 40.359±0.252 | P<0.0001 t=40.423 |
| Creatine phosphokinase | 895.374±0.184 | 2650.465±0.321 | P<0.0001 t=13138.85 |
| Albumin | 3.328±0.243 | 2.5816±0.295 | P<0.0001 t= 5.513 |
| Total Proteins | 5.511±0.265 | 4.365±0.242 | P< 0.0001 t= 9.024 |
| Creatinine | 0.133±0.009 | 0.1838±0.007 | P<0.0001 t=11.94 |
| Blood urea nitrogen | 19.422±0.170 | 28.512±0.238 | P<0.0001 t=87.649 |

The assessments of haematological parameters are very crucial to determine the detrimental effects of MWR generated by mobile phones in experimental animals. It helps in monitoring and determine the consequences of the MWR induced hazardous alterations to humans. Findings of the study, revealed that the levels of red blood cells declined significantly in experimental animals exposed to mobile phone generated electro- magnetic waves generated. The depletion in red blood cells may be due to inflammation, similar conditions may find in anaemia and leukaemia conditions. Similarly, Mean Corpuscular Haemoglobin (MCH) are medically significant in the diagnosis of anaemia. The results of the study clearly revealed that the electromagnetic waves alter the cell walls. Similar reports have been reported on cell wall damages, especially the walls of red blood cells. This leads imbalance in blood enzymes [28, 29]. Elevated levels of cell apoptosis and functional damage in wide variety of cells due to MWR, even it could be possible in cancer treatments [30].

The serum activity levels of AST, ALT, ALP, and ACP increased significantly in the experimental animals while compared with their respective control groups. This evidenced that MWR of mobile phones are disrupts the cell membrane, fluctuations in cellular and subcellular levels, which leads to inhibition in signal transduction pathways. The direct damage of this phenomena is metabolic disturbances in hepatocytic cells and fluctuations in cytosolic enzymes. The significant increase in levels of ALT indicates the non-ionizing radiation induced influence on hepatocytes, leads to apoptosis, necrosis and cell damages [3, 31].

The significant increase in liver function enzymes indicates the damage to hepatic cells and the production of free radical. The environmental factors influence the electromagnetic waves, even in low intensities MWR induces the oxidative stress in organisms and mammals [32]. Most of the electromagnetic waves increases the body temperature of the exposed organism, subsequently it leads to damage of cell membranes, vessels, internal organs, and finally severe internal bleeding. Several studies have been reported on electromagnetic induced deleterious effects like free radical generation due to oxidative stress, genotoxicity, impaired antioxidants, and hypothermia [32,33,34].

The LDH considered as cellular marker enzyme, findings of the study suggest that LDH levels increased significantly in experimental animals after exposed to MWR of mobile phones. Similar results were found in the serum of occupationally exposed volunteers to high frequency radiations [35]. These findings indicate the deleterious effects of MWR, radiation may increase cell death and tissue homeostasis exposed organisms [36]. Angiographic findings showed the significant correlation between myocardial enzymes in serum, association between HDL and CAD levels and considered as inflammatory biomarkers [37]. In accordance with above results, the findings of the investigation revealed that the radiation influences the cardiac enzymes significantly in the experimental group and may prone to cardiovascular disease. The levels of urea and creatinine increased significantly in experimental groups, similar reports were found in humans those who carry their mobiles often in belts. It indicates that kidneys absorb the mobile radiation and alters the levels of urea and creatinine, which may emit 900-MHz electromagnetic radiation [38]

A marked reduction of total proteins and albumin were found in the present study in accordance with the results of kula [39]. The reductions in the levels of total proteins and albumin due to malfunction of the absorption process, impaired synthesis of liver albumin, and proteins [40]. Due to radiation induced oxidative stress serum creatinine levels increases significantly in experimental animals after exposed mobile phone electromagnetic radiation. Hence, the results elevate the association between cell phone radiation and cellular damage, in turn results in elevated levels of serum creatinine [41,42]. Electromagnetic radiation induced rise of local temperature leads formation of free radicals. Later the free radicals attack the lipids, proteins by breaking their bonds causes the deleterious effects to cells [43, 44]

Electromagnetic field radiation causes the, haemorrhage, inflammation, congestion, architectural damage to liver, kidney and heart [45]. Similarly, various studies have been reported that mobile phone radiation induced a significant depletion in concentrations of serum. Radiation damages the pituitary, production of Leydig cells, hypothalamus and alterations in secretion of gonadotropin [46,47]. In biological systems of mammals, mobile radiation induces the generation of free radicals, enhanced levels of lipid peroxidation and extravasation of RBCs in the myocardium, further disruption the cardiac fibres. EMF radiation induces the atherosclerosis, inflammation, and carcinogenesis [48]

In contrary, activity levels of ALT, GGT and LDH reported not changed significantly in experimental animals. However, the activity levels of AST increased in rats exposed to radiation. Significant increase in activity

levels of ALT describes cytotoxic alterations of non-ionizing radiation induces apoptosis, necrosis, disruptions in cell membrane [31]. Non-thermal radiation damages the nervous system as described by increased lipid peroxidation, protein oxidative stress in experimental animals [49].

Interestingly, effects of increased levels of lipid peroxidation lead to cellular fluid loss, decrease in electrical resistance, depression in protein mobility in the membrane and increased phospholipids exchange between the bilayers of the membrane [50]. Indirect effects are oxidation of polyunsaturated fatty acids, and oxidative stress- mediated lipid peroxidation in brain of the experimental rat [51].

The findings revealed and evidenced that the mobile radiation is harmful effects on enzyme activity and tissue. The negative effect on human health is due to hypothermia and free radical that increase oxidative stress and cause damage to internal body organs. Microwave radiation of mobile phones induces the deleterious effects to cell membrane alter the functions cell membrane through ion flux and enhanced penetrance.

Significant increased levels of lipid peroxidation revealed the direct effect on hepatocytes and damage of brain cells under mobile phone microwave exposure. increased ALT activity, impairment of cells, loss of fluid, increased permeability, hepatocellular damage may cause hyperkalaemia, neurogenerative dysfunctions. These findings could explain the weight gain, increased appetite and behavioural changes in experimental animals when compared with their respective control groups.

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