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Mobile Tower Exposure affects on memory and Motor Co-ordination on Mice

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ABSTRACT

Mobile is now become as an integral part of our daily life and mobile users have been increasing day by day globally. In India, mobile base stations and their installation are irregular and unregulated. Result from STM (Short term memory) and LTM (Long term memory) test, showed significant change in Mobile Tower Radiation Treated Mice (MTRTM) as compared with without MTR treated mice. The numbers of mistakes done by MTR-TM group of mice were higher than the control. After measuring the muscular strength by using rotating hanging wire test, the result revealed that calculated time of fall from wire and compare this time with control and radiated set of mouse. Three trials were done with same set of mouse at one week intervals. In all the three trials, the average difference between control and radiated mice for muscular strength was significant ($p < 0.05$). Path movement was more random in MTR-TM and also observed less activity than without treated control mice.

1) INTRODUCTION

There has been an unprecedented growth in the global communication industry in recent years, which has resulted in a dramatic increase in the number of wireless devices [1]. Introduction of cellular phone systems and the rapid increase in the number of users of cellular phones have increased exposure to electromagnetic fields (EMFs). Health consequences of long-term use of cellular phones are not known in detail, but available data indicates that development of nonspecific health symptoms is possible. This invisible health hazard pollution (IHHP) is a relatively new environmental threat. Mobile services were launched in India in 1995 and it is one of the fastest growing mobile telephony industries in the world. According to the Telecom Regulatory Authority of India [2], the composition of telephone subscribers using wireless form of communication in urban area is 63.27% and rural area is 33.20% [3]. This has led to the mushrooming of supporting infrastructure in the form of cell towers which provide the link to and from the mobile phone. With no regulation on the placement of cell towers, they are being placed haphazardly closer to schools, public playgrounds, on commercial buildings, hospitals, college campuses, and terraces of densely populated urban residential areas. Hence, the public is being continuously exposed to low intensity radiations from these towers. Since the electromagnetic radiations/ EMFs, also known as electro smog cannot be seen, smelt or felt, one would not realize their potential harm over long periods of exposure until they manifest in the form of biological disorders. Various studies have shown the adverse effect of radio-frequency

electromagnetic field (RF-EMF) on bees, fruit flies, frogs, birds, bats, and humans, but the long-term studies of such exposures are inconclusive and scarce, and almost non-existent in India [4, 5].

The electromagnetic radiations are of two types, one being ionizing radiations such as X-rays and gamma rays, and the other being non-ionizing radiations such as electric and magnetic fields, radio waves, radio-frequency band which includes microwaves, infrared, ultraviolet, and visible radiation (Fig. 1). While, India has adopted ICNIRP guidelines as the standard for safety limits of exposure to radio-frequency energy produced by mobile handsets for general public as follows: whole-body average SAR of 0.08 W/kg, localized SAR (specific absorption rate) for head and trunk of 2 W/kg, and localized SAR for limbs 4 W/kg [6]. Every living being is tuned into the earth's electromagnetism and uses it for various purposes. A natural mineral magnetite, which is found in living tissues, seems to play an important role. These magnetite crystals are found in bacteria, protozoa, teeth of sea mollusks, fish and sea mammals, eye and beak of birds, and in humans [7, 8].

Several reports are available about Mobile tower Radiation (MTR) ill effects and induced genotoxicity, cancer-related gene and protein expression, cell proliferation and differentiation, and apoptosis and *in vivo* studies include thermal effects, animal behaviour, brain biochemistry, neuropathology,

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teratogenicity, reproduction and development, immune function, blood-brain barrier, visual auditory systems and effects on genetic material, cell function, and biochemistry [9, 10, 11]. Flying ants are very sensitive to electromagnetic fields [10]. Tower-emitted microwave radiation affected bird breeding, nesting, and roosting in Valladolid, Spain [12]. On the behavioral level, including the Morris water maze (MWM), radial arm maze, and object recognition task have been extensively used to test cognitive impairment following exposure of rodents to mobile phone radiation (GSM 900 MHz) on various frequencies and SAR values [13].

Exposed animals in most of the cases revealed defects in their working memory possibly due to cholinergic pathway distraction. Mobile phone RF-EMF exposure significantly altered the passive avoidance behavior and hippocampal morphology in rats [14]. EMRs on biological effects have been extensively known from epidemiological and experimental studies [15, 16, 17, 18].

Effects of cell base station on memory and memory related function is broadly studied by several researchers throughout of the world [17, 18, 19]. Therefore, frequent reports and study were found on anatomical study [20] while, scanty of information available for functional analysis on living being [16]. In this connection, the present study with aimed to observed the function behaviour change in mice under mobile tower radiation.

2) MATERIALS AND METHODS

2.1 Experimental setup: behaviour study for mouse

Male Swiss albino male mice (six weeks aged) were used in the present study. Animals were bred during summer in central animal house, Institute of Pharmacy, V.B.S. Purvanchal University, Jaunpur-India. All the animals were kept in housed polypropylene cages using paddy husk bedding at $28\pm 2^\circ\text{C}$ temperature and $50\pm 5\%$ humidity, fed according to standard laboratory feed and water. Animals were kept in such a manner to avoid overcrowding in housed-cage. Mobile tower radiation treatment for behavioural study was conducted with a group. Mice were divided in four groups (four mice in each group). One group was used as a control (without radiation) and other three groups were kept for radiation exposure (Mobile tower radiation: MTR). For radiation exposure, mice cases were kept around mobile tower within 50 meter of radius. Six weeks old mice were kept under MTR radiation exposure up to 18 weeks. All behavior experiment was performed on controlled mouse (CM) and MTR treated mice (MTR-TM).

2.2 Short term and long term exposure of MTR

Adult mice (25 weeks, old) were taken from different groups. LTR exposure on mice was given M for the duration of 1, 2, 3, 4 and 5 weeks while STR exposure was given for 1, 12, 12, 18 and 24 hours. For memory test, self administrated designed equipment with wooden box was used in which two compartments (dimension $12 \times 12 \text{ cm}^2$) were separated by single door. Two electrodes connected with battery and fitted in door, food and mice were kept in different compartment respectively. The concept for equipment designing was based on mice attracted towards food and trying to reach in another compartment through eclectic fitted door and get shock. When

mice will try for food they will get shock and return back. It depends upon memory how long they remember this electrical shock. Numbers of sock were calculated as a mistake per hour. Experiment was performed after three days acquisition. Mice were kept in box after 5 and 60 minutes. Calculation of mistakes in 5 minutes has been called short term memory (STM) and 60 minutes has been called long term memory.

2.3 Open field test for anxiety and exploration habit

All groups of mice (control and MTR-TM) were subjected to open field test to know effect of MTR on locomotors activity. Forty four centimeter of radius (12 centre, 24 periphery and up to 44 border) and 12 centimeter height instrument were made by steel and painted by white paint. One web camera and 60W illumination was installed with open field test instrument at 7.5 feet height to monitor mice movements. Mice were kept at centre of axis and monitored movement for each 60 second.

2.4 Rotarod test for motor coordination test

Rotarod test was performed to know the motor coordination status in MTR exposed mice and control. Motor coordination assays were performed in a rotating pole (55 inch length, 1.6 inch diameter) test as earlier described [21], set at a height of 46 inches from the floor. The latency period was calculated by time of fall from rotarod at constant speed (35 rpm). The following rating scale was used, as adapted and described by Mattiasson et al. [21]: viz. 0 = 0 to 2 inches or 0 to 2 seconds; 1 = 2 to 11 inches or 2 to 12 seconds; 2 = 11 to 22 inches or 12 to 24 seconds; 3 = 22 to 33 inches or 24 to 36 seconds; 4 = 33 to 44 inches or 36 to 48 seconds and 5 = 44 to 55 inches or 48 to 60 seconds. In this scale, therefore, "0" represents the poorest motor coordination, and "5" represents the best motor coordination.

2.5 Statistical analysis

The data obtained were subjected to ANOVA, and means were compared with Duncan's multiple range test. All statistical analyses were conducted using SPSS (Version 14; IBM, Armonk, NY, USA).

3) RESULT AND DISCUSSION

Mobile is now integral part of our daily life. The mobile users are increasing day by day. In India, mobile base stations and their installation are quite irregular and unregulated. In this connection present study was carried out with conclusive result of mobile tower radiation and its effect on mice. Results revealed in the present study, the behaviors of mice were altered under exposure of MTR (Fig. 1 to 5). Mice were tested for long term and short term memory with self designed instrument and compared between control and MTR-TM (Fig. 1 and 2). In the case of STM test, we standardized 5 minutes to test for mistakes. In self design memory- instrument, control mice were done 2.2 and radiated 4.1 mistakes in 5 minutes in first trial. In second and third trial were done after one week of interval with same set of animals. The numbers of mistakes were drastically down (Fig. 1 and 2). Control mice were done 1.1 and radiated 3.1 mistakes in 5 min in second/third trials. For LTM test, we kept mice for one hour and observed their mistakes including initial 5 minutes with other set of mice. In first trail we observed 3.4 mistakes in control and 6.5 mistakes in radiated mice, results revealed at a par for second and third trial (Fig. 2 and 3).

MTR exposure significantly altered the passive avoidance behavior and hippocampal morphology in rats [14].

either by facilitation or inhibition [22]. Continuous exposure of microwave frequency affected memory recognition. In the

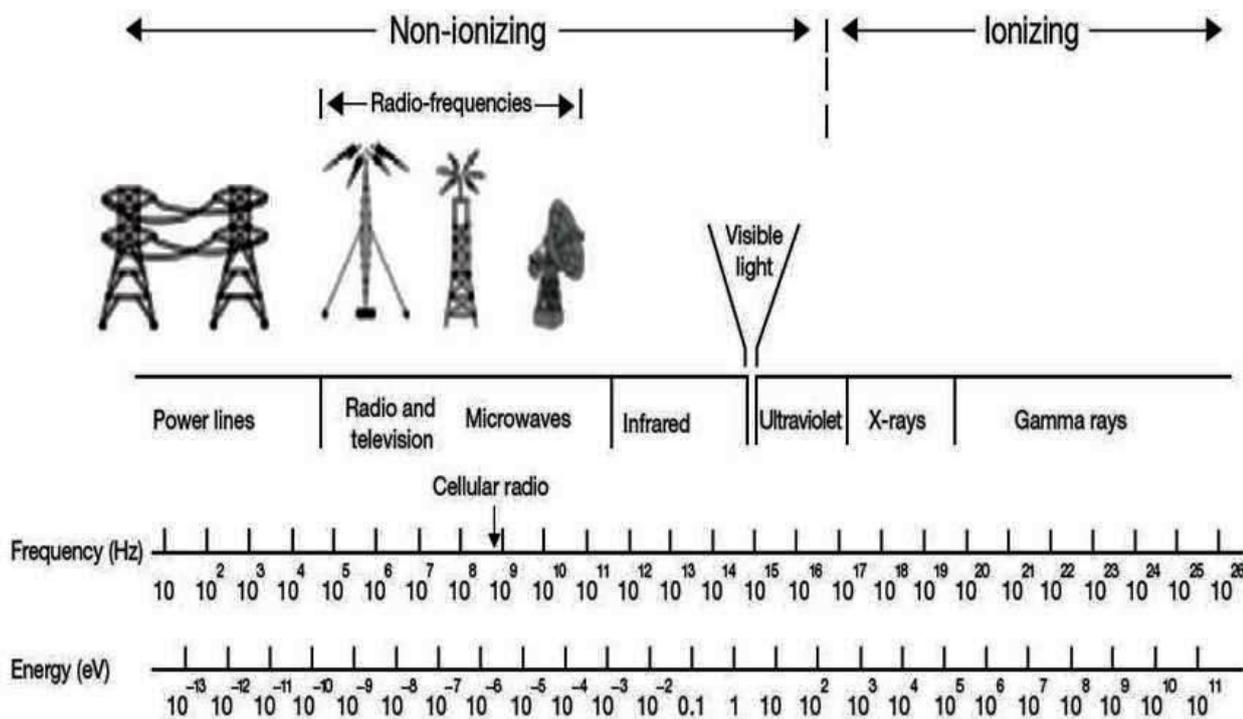


Fig. 1: Electromagnetic spectrum from the Federal Communications Commission (FCC), OET Bulletin 56, 1999.

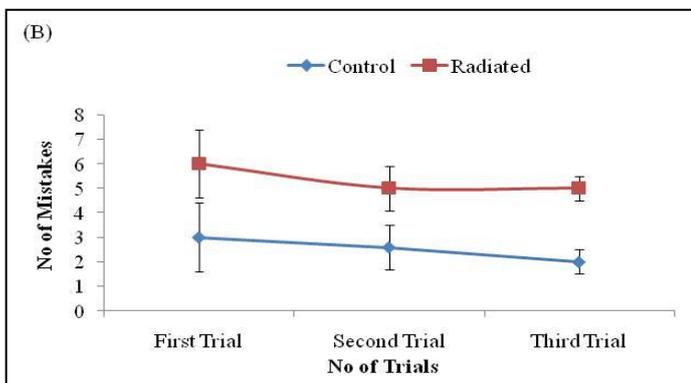
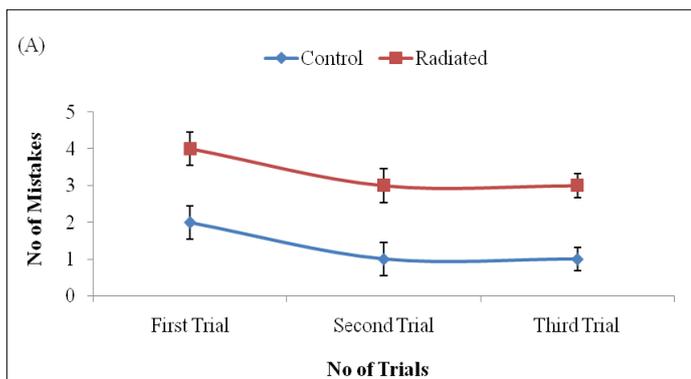


Fig. 2: Short term (A) and Long term (B) memory test of radiation treated mice on the basis of their mistakes.

Populations living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions

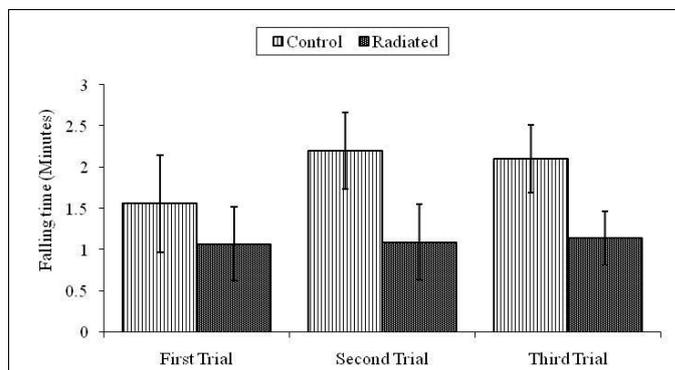


Fig. 3: Performance of Hanging wire test for muscular strength in radiation treated mice after different trials

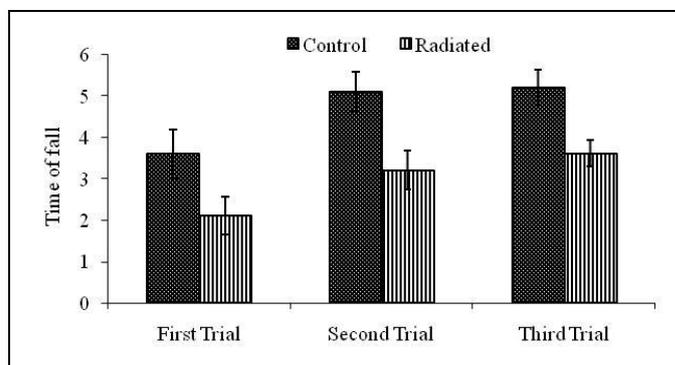


Fig. 4: Performance of radiation treated mice on the basis Rotawator test.

present study, the number of mistakes done by MTR-TM group was higher than control (Fig. 2, 3 and 4). It shows

MTR-TM groups having higher tendency to forget electrical shock and STM most affected than LTM (Fig. 2, 3 and 4). Long term memory, was about unaffected *i.e.* the mistakes including initial 5 minutes and rest 55 minutes almost at a par with little increase.

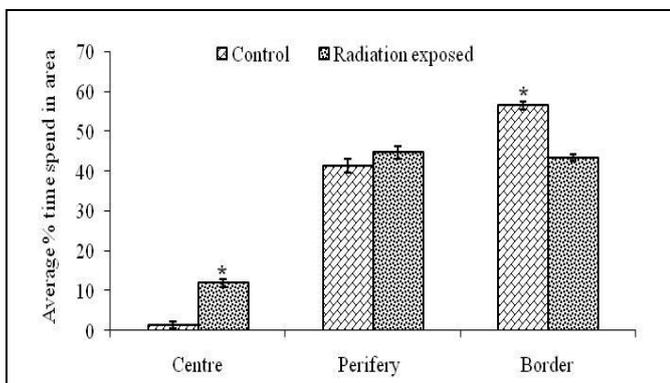


Fig. 5: Time spends by radiation treated and non-treated (Control) mice in self design area for memory test.

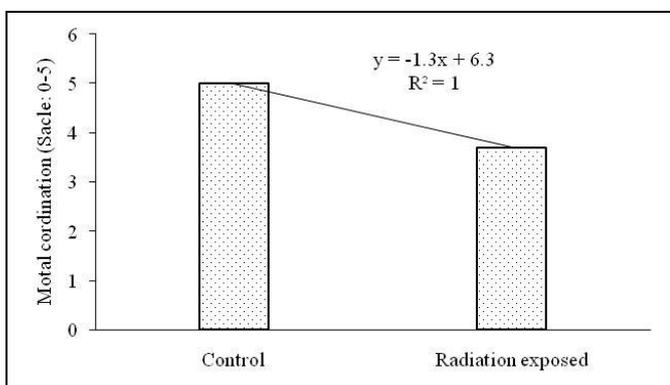


Fig. 6: Analysis of motor coordination among radiation treated and non-treated (Control) mice.

So, it might be concluded that MTR may affect short term memory. Electrical shock learning process was same in radiated and control group. So, it might be MTR may not affect learning process. In this connection, Dubey [19] reported significant decrease in ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels. Mobile tower Radiation (MTR) caused ill effects and induced genotoxicity, cancer-related gene and protein expression, cell proliferation and differentiation, and apoptosis and *in vivo* studies include thermal effects, animal behavior, brain biochemistry, neuropathology, teratogenicity, reproduction and development, immune function, blood-brain barrier, visual auditory systems and effects on genetic material, cell function, and biochemistry [23, 24]. Muscular strength was measured by rotating hanging wire test, and the result revealed that calculated time of fall from wire and compare this time with control and radiated set of mouse. Three trials were done with same set of mouse at one week intervals (Fig. 3). In all three trials, the average difference between control and radiated mice for muscular strength was significant ($p < 0.05$). Radiation effects and muscle strength is also inter-linked. In the present study, it was clear that the significant decreases in falling time from wire indicate their muscular weakness. The exact mechanism about microwave radiation affects on muscular efficiency is still not known.

Motor coordination plays very important role in daily life, and it is very necessary to coordinate among different body parts for proper functioning. In the present study, rotawator test was used to measure motor activity in the mice, and it was calculated for time of fall from wire and compare with respect of time in both control and radiated set of mice (Fig. 4). All the three trials were done with same set of mice after one week of intervals. It was observed that difference in motor function, while it was not statistically significant ($p < 0.05$).

Conclusion was drowning based on the present study; motor coordination was affected up to certain extent but not up to significant level. The survival of muscle synergies has been a neural tactic of multiple degrees of coordination. One muscle can be part of multiple muscle synergies, and one synergy can activate multiple muscles (Fig. 5 and 6). De Iuliis et al. [25] by subjecting *in vitro* samples of human spermatozoa to radio-frequency radiation at 1.8 GHz and SAR of 0.4–27.5 W/kg showed a correlation between increasing SAR and decreased motility and vitality in sperm, increased oxidative stress and 8-Oxo-2-deoxyguanosine markers, stimulating DNA base adduct formation and increased DNA fragmentation. GSM mobile phone exposure can activate cellular stress response in both humans and animal cells and cause the cells to produce heat shock proteins (HSP27 and HSP70) [26].

To measure physical activity, the present study, and used rounded box with video recoding facilities for 5 minutes, and movement path of mice were drawn graphically. And the result revealed that the movement of path was not clear in MTR-TM and them less activity than control (Fig. 5 and 6). Less activity of locomotors coordination depends on multiple factor and phenomenon. It needs coordination between brain, neurons and muscles. Less activity means less coordination, but exact reason is still not clear [19].

Electromagnetic Radiations use is predictable by the people; it is require developing more broad safety measures [19]. In the present observation on mice, indicated that adverse health effects due to MTR. Therefore, it is urgent need for more research to develop sustainable approach between MTR and Environment as well as living being.

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