



EFFECT OF 1800-2100 MHZ MOBILE PHONE ELECTROMAGNETIC RADIATION ON MICE HIPPOCAMPAL CA3 NEURONS

Anatomy

G. Krishna Kishore*

Ph.D Scholar, Department of Anatomy, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India. *Corresponding Author

Dr. Venkateshu K. V

Professor, Department of Anatomy, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India.

Dr. Sridevi N. S

Professor & HOD, Department of Anatomy, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India.

ABSTRACT

Increase in interaction through the mobile phone may have adverse effects on the brain, especially on the hippocampus. so the radiation emitted from the mobile phone and its adverse effects is a serious concern in the society. In this study we have focused on the effects of chronic exposure to Mobile phone Radio Frequency-Electro Magnetic Radiation (MP RF-EMR) on hippocampal CA3 neurons in swiss albino mice were investigated. 18 Swiss albino mice were divided into 3 Groups (Control, 30 Mins exp/3 Months & 60 Mins exp/3 Months). After the exposure the mice were euthanized, perfused transcardially, brains were extracted out and processed for histological procedures. Cresyl Violet stained hippocampal CA3 Pyramidal neurons shows more number of viable neurons which is healthy, compactly arranged with clear nucleus in control group, where as radiation exposed group neurons shows darkly stained, unhealthy, scattered and irregular with less number of viable neurons. The findings indicate that chronic exposure to mobile radiation leads to change in structural integrity of hippocampus also alter the cognitive function like learning and memory.

KEYWORDS

Mobile phone RadioFrequency-ElectroMagnetic Radiation(MP RF-EMR), CA- Cornu Ammonis

INTRODUCTION

Enormous usage of the mobiles throughout the world increases the concern on the effects of mobile radiation on human's health especially on the brain, as the mobiles will be kept closer to the head region during communication¹. It is estimated that in 104 countries around 80% of the youngsters are in online, 94% of youngsters aged 15-24 years are using internet in developed countries, 67% are using internet in developing countries and only 30% are using internet in least developed countries. It is alarming that out of 830 million youngsters who are in online 320 million (39%) are in India and China. The proportion of youngsters aged 15-24 years using internet data (71%) is much higher than the total internet users (48%). In 2017, the proportion of internet users in terms of gender shows men were higher in number than the women users in 2/3rd of the countries worldwide, United States is the only country in which women users percentage were higher in using the internet².

The facts that is alarming with many of the mobile devices is that they were releasing into the market without proper safety approvals and guidelines on electromagnetic radiation. In 2011, WHO confirmed that mobile phone usage will be a health hazard and classified mobile radiation may be possibly carcinogenic³. In 2010, WHO releases a research agenda for radiofrequency fields-high priority research on neurodegenerative diseases and ageing in animal models⁴. Currently the adverse effects of health due to radiation frequency emitted by mobile phones are not clearly understood and still contradictory. In spite of many advantages, long term usage/exposure to mobile phone can be considered as an "health time bomb", because the over usage of mobile phone for more than 20 minutes increases the contact tissue temperature to 1°C⁵. Over usage of mobile phone may result in difficulty to do the daily activities on time, poor fragmented sleep, affects learning capacity, mental health and quality of life⁶.

Hippocampus is the sensitive target region among the central nervous system which is more susceptible to damage by electromagnetic field and extremely an important component of limbic system because of acquisition and integration of memory. Short term memories will be storing temporarily and been converting into long term memories, deposited permanently⁷. Hippocampus is a "S" shaped folded structure located in inferior horn of the floor of the lateral ventricle, which consists of hippocampal proper (CA1, CA2, CA3) and dentate gyrus. Pyramidal cells are the chief cells of hippocampal region⁸. Damage to the neurons of hippocampal region may lead to impairment in memory and learning, behaviour disturbances and negative impact on Hypothalamo-Pituitary-Adrenal axis, Developmental alterations/

anomalies in brain/CNS due to electromagnetic field will remain for the rest of the life⁹.

Numerous studies were focused on the effects of acute Mobile Phone Radio Frequency Electro-Magnetic Radiation (MP RF-EMR) exposure on hippocampus, reporting a hippocampal cell injury. But there are very few studies which has focused on chronic exposure of mobile radiation. Hence, the present study was aimed at studying the chronic effects of mobile radiation exposure on hippocampus of adult swiss albino mice.

MATERIALS AND METHODS

The study was carried out after the approval of Institutional Animal Ethical Committee (IAEC/PHARMA/SDUMC/2017-18/04). The study was conducted at central animal house, Sri Devaraj Urs Medical College, Kolar, Karnataka.

Animals:

Six weeks old healthy male Swiss-Albino Mice were used in this study, the animals were procured from committee for the purpose of control and supervision of experiments on animals (CPCSEA) registered brooders-Invivo Biosciences, Bengaluru.

The Swiss-Albino Mice were kept in polypropylene cages with a temperature of 23±2 °C, Humidity 55±5% and 10 hours light, 14 hrs dark cycle and free access to standard pellet food and water ad libitum. The experimental animal care was taken as per the committee for the purpose of control & supervision of experiments on animals (CPCSEA) guidelines.

Experiment Design:

A total of 18 Male Swiss-Albino Mice were taken and divided in to three groups.

Group I: control group - consists of 6 mice (non-exposed group).

Group II: 30 minutes exposure group – consists of 6 mice exposed to MP RF-EMR for 30 mins/day for 3 months.

Group III: 60 minutes exposure group – consists of 6 mice exposed to MP RF-EMR for 60 mins/day for 3 months.

After the exposure the mice were euthanized, perfused transcardially with normal saline and the brains were extracted out, fixed in 10% buffered formalin and then processed for histological procedures, 6µm

paraffin sections were taken using rotary microtome at the level of the dorsal hippocampus to assess the hippocampal CA3 neuronal damage with the help of Cresyl violet staining. Viable neuronal quantification was assessed with the help of ocular micrometer fixed to light microscope (40X). From each mice ten sections were selected for viable neuron quantification.

Mobile Phone: 4 G android mobile phones (Micromax) were used in this study, keeping a GSM (2100 MHz) mobile phone in silent with auto answer mode. The mobiles were hung down from the roof of the mice cage and the radiation which was emitted during the exposure was quantified by radiation frequency meter (Electrosmog Meter-ED 178 S).

Exposure technique: Animals of group II & III were exposed to 30 mins & 60 mins/day for 3 months. The mobile phones were hung down in the cages during the time of exposure.

Statistical analysis:

The results were expressed in Mean ± Standard Deviation. One-way ANOVA and Bonferroni's post-hoc test were used to compare the significance between control and exposed groups. P < 0.05 was considered as statistically significant. (Statistical Package-SPSS version 20)

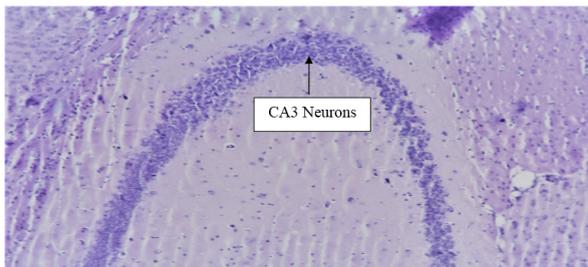
RESULTS

Neuronal damage assessment in CA3 region of hippocampus:

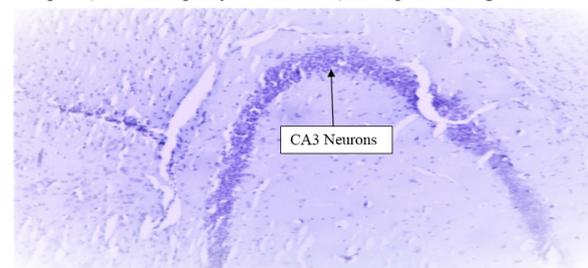
The pyramidal neurons of hippocampal CA3 region in control group shows healthy neurons which is compactly arranged with clear nucleus, where as mobile phone radiation exposed mice hippocampal CA3 neurons shows darkly stained, unhealthy, scattered and irregular, as illustrated in figure 1, 2 and 3.

Figure 1: Cresyl Violet stained photographic images of hippocampal pyramidal cells in CA3 region of mice brain from control and radiation exposed groups.

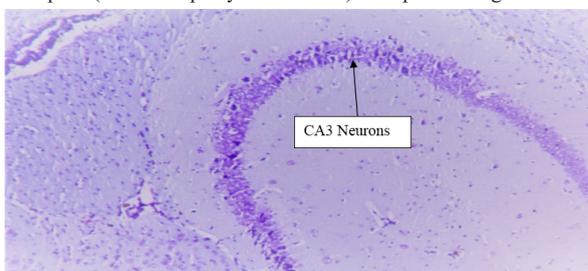
Group- I (Control group)-Low power image



Group- II (30 mins exp/day for 3 months)-Low power image



Group- III (60 mins exp/day for 3 months)-Low power image



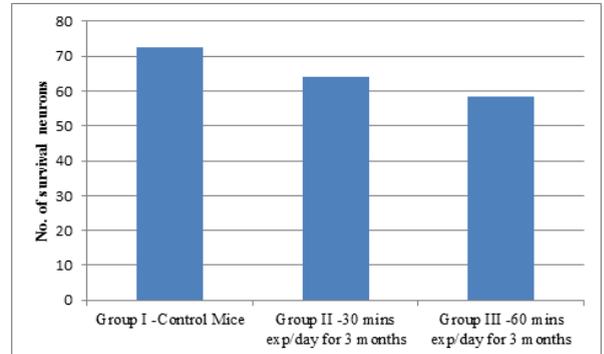
Quantification of viable neurons in hippocampal CA3 region

Total mean number of viable pyramidal CA3 neurons in group-I

(Control group) 72.5±8.34 vs group-II (30 mins exp/day for 3 months) 64.1±8.13 was statistically not significant (P>0.01), whereas group-I (Control group) 72.5±8.34 vs group-III (60 mins exp/day for 3 months) 58.3±6.81 was statistically significant (P<0.001).

So the results in this study shows that increase in the duration of exposure to mobile phone radiation leads to increased damage of the hippocampal CA3 pyramidal neurons, as illustrated in graph 1.

Graph 1: Quantification of hippocampal CA3 survival neurons in control and radiation exposed groups.



DISCUSSION

Increase in the usage of wireless communication raised the concerns of its adverse biological effects and potential health risks on the central nervous system, especially on the hippocampus as it is a sensitive region which is responsible for cognition like learning and memory. Although some studies were carried out to assess the radiation effects on memory-learning, cellular architecture, epidemiological studies and toxicology studies on laboratory research animals, still it is controversial⁸.

In the present study, we have focused on the effects of mobile phone radio-frequency electromagnetic radiation on the cellular architecture and quantification of hippocampal CA3 pyramidal neurons, which shows compactly arranged healthy neurons with clear nucleus in control group, where as radiation exposed group shows unhealthy neurons which is darkly stained, scattered and irregularly arranged.

Neuronal quantification of hippocampal CA3 pyramidal neurons reveals that presence of less number of viable neurons in radiation exposed group compared to control group.

In a study done by Bolla SR, reported that decreased number of viable neurons in the hippocampus may be because of effect of neurogenesis and exposure to mobile radiation for 2 hrs/day can up-regulate the apoptotic pathway¹⁰. In 2013, Afeefy AA et al reported that, microscopic anatomy of radiation exposed hippocampal pyramidal neurons in CA3 region shows variable degrees of degeneration, irregular in shape and decreased cytoplasmic nuclear ratio with nuclear wall disruption. The results were similar with our study⁸. Chronic exposure to mobile radiation alters spatial learning, decreased hippocampal CA3 pyramidal neurons and remodelling of dendrites. Structural changes and decreased hippocampal neurons may be one of the cause for altered cognitive function¹¹.

900 MHz electromagnetic radiation exposure for 1 hr/day in adolescent rats (21st day to 59th day) results in decreased hippocampal pyramidal cell count and morphological changes like darkly stained cytoplasm with shrunken pyramidal cells were observed⁷. Rats exposed to 900 MHz radiation for 1 hr/day results in increased malondialdehyde levels, xanthine oxidase levels and decreased glutathione peroxidase activity, superoxide dismutase levels. These changes in the brain was prevented by giving ginkgobiloba¹².

CONCLUSION

The results in our study reveals that prolonged exposure to 2100 MHz mobile phone electromagnetic radiation leads to damage and change in structural integrity of hippocampal CA3 pyramidal neurons. The change in structural integrity of hippocampus may alter the cognitive function like learning and memory.

Conflict of Interest: None

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