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EFFECT OF EXPOSURE OF MOBILE PHONE RADIATIONS ON RED BLOOD CELL OF MICE- A SCANNING ELECTRON MICROSCOPIC STUDY

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ABSTRACT

The fourth generation (4G) smart phones handset emits extra radiation due to MIMO (multiple inputs and multiple outputs) systems than third generation (3G) smart phones handset. Present study was designed to compare and evaluate the detrimental effect of radiofrequency electromagnetic field (RF-EMF) radiation emitted from 3G & 4G cell phone on red blood cells (RBCs) through scanning electron micrograph (SEM). The Swiss albino mice were exposed to 3G mobile phone (SAR =0.406 W/Kg & 0.562W/Kg for body and head respectively; average power density: 0.998 mW/cm^2), and 4G mobile phone (SAR = 0.458 W/Kg & 1.520W/Kg for body and head respectively; average power density: 1.032 mW/cm^2) during video call for a period of 4 hours/day for 120 days. Several morphological alterations were observed in the RBCs of both the exposed groups. SEM of RBCs has altered membrane. poikilocytosis, anisocytosis and macrocytosis were evident in both 3G & 4G groups. The extents of alteration were higher in 4G exposed group. Interestingly, ost of the changes were recovered to normal after removal of exposure for 30 days.

Keywords: Mobile Phone Radiations; 3G; 4G; RBC; SEM; Swiss Albino Mice.

INTRODUCTION

The mobile phone has become an inseparable and necessary part of our life, which simultaneously raised the concern and research in order to determine the possible effect of electromagnetic radiation emitted by them (Odaci, **2**008; Azmy *et al*., 2013). The electromagnetic fields (EMFs) radiated by these devices are absorbed by body tissues and cause the distress by interfering with the body's own electromagnetic energy system (Ongel, 2007). The RBCs constitute about 99% particulate matter in the blood and transport oxygen to all parts of the body. RBCs have paramagnetic properties due to the iron containing hemoglobin molecules. The paramagnetic property of the RBCs may be affected by electromagnetic magnetic field (Ngelucci *et al.,* 2010).

Previous studies have also reported that EMF exposure from different sources may reduce permeability and elasticity of RBC membrane (Ali *et al.,* 2003), alter the structure of hemoglobin (Yao *et al*., 2005), caused rouleaux formation (Singh *et al*., 2012; El-Bediwi *et al*., 2013) and can change the deformability and solubilization of RBCs membrane (Fadel *et al*., 1994). However, the studies involving the effect of radiofrequency radiation (RFR) of cell phones on RBCs are lacking and no comparative studies were reported so far. So, in this study we made an attempt to compare and analyze the health hazards of RF-EMF radiation of 3G and 4G mobile phone on RBCs of *Swiss* albino mice. The study was further extended to note the recovery after removal of exposure.

MATERIAL AND METHODS

Experiment was conducted after obtaining permission from institutional ethical committee (IEC), Maharaja Agrasen University, Baddi, Solan, HP (Approval No. MAU/SBAS/2019/206, Dated 10.10.2019). A total of thirty six (36), adult male Swiss albino mice of 6-8 weeks old were randomly divided into three groups having twelve mice in each group. Group I was used as control. The mice of Group II were exposed to 3G mobile phone, while Group III was exposed to 4G mobile phone, during video call from a distance of 6-8 cm for 4 hours/day for 120 days. Mobile phones were programmed in auto answer mode. Similar mobile phone sets as well as same service provider were used for both the exposed groups (3G&4G). Control as well as experimental animals were exposed similar environmental conditions (temperature 25 ± 3°C, relative humidity of 60±10% and light & dark cycle of 12/12 hours),except the exposure field. After proposed exposure of 120 days, 50% mice from each group were

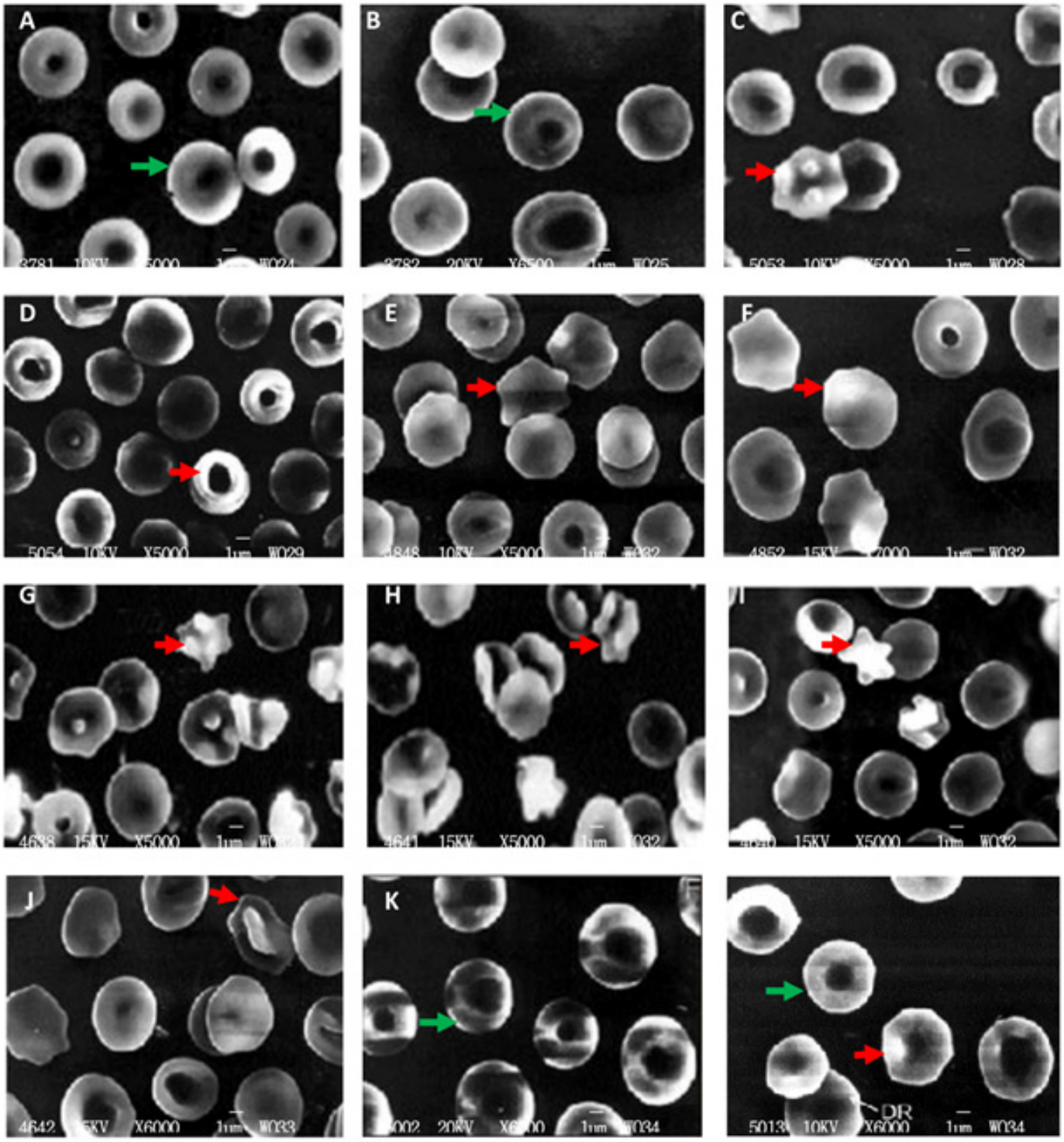

Fig.1. Scanning Electron Micrograph of RBCs of Control mice (A, B) showing the normal shape (green arrow), 3G exposed mice (C,D,E,F) showing affected RBCs (red arrow), 4G exposed mice (G,H,I,J) showing affected RBCs (red arrow), RBCs of 30 days post irradiated 3G mice (K) showing the normal shape (green arrow) and 30 days post irradiated 4G mice (L) showing the normal shape of RBCs (green arrow) and affected RBCs (red arrow).

sacrificed, while remaining 50% mice were kept for 30 days unexposed, to observe the recovery if any due to removal of radiation exposure. The experimental design and exposure conditions are shown in the Table.1 below.

Sample Preparation For Sem Studies

The samples were prepared by using method of Clarence *et al.,* (1974) and RBCs were separated using method of Czuprynski and Brown, 1998. For SEM, a drop of blood was directly fixed in 2.5% glutaraldehyde in phosphate buffer saline (PBS), pH 7.2 for 30 min and then centrifuged at 600g in REMI, 8C centrifuge at room temperature. The pellet was washed thrice in 10 ml PBS, pH 7.2 after discarding the supernatant each time. Finally, the pellet was washed in triple distilled water three times. Suspension of cells in distilled water was placed on a silver foil over an iron stub. After air drying, stub was sputtered for 30 min in a sputterer and viewed in SEM (JEOL JSM-6100 scanning microscope) in Central Instrumental Laboratory, Panjab University Chandigarh at different magnifications.

RESULTS AND DISCUSSION

The health status of experimental animals can be easily determined by measuring blood parameters (Soud, 2004). Moreover, the average size of RBCs can give a clear picture of its performance and efficiency (Al-shaera, 1991). Red blood cells (RBCs) of the peripheral blood of control (C) and exposed groups (3G and 4G) were subjected to scanning electron microscopy to note the change in the surface of these cells as a result of exposure. The RBCs of control group of mice revealed normal size, shape and morphology under SEM. RBCs appeared biconcave and oval in shape (Fig.1.A&B). Several morphological alterations were observed in the RBCs of both the exposed groups. Most of the RBCs have abnormal shape (poikilocytosis). Some RBCs appeared unequal sized (anisocytosis) while few RBCs were bigger than normal size (macrocytosis). Bulging and protuberances were seen on surface of exposed red cells, some cells appear star shaped (Fig.1.C-J), which are consistent to previous studies, where EMR of video display unit (VDU) caused alteration in the RBC membrane (Singh and Bagai, 2013). Our results are also in agreement with Yong *et al.,* (2013) who reported an increase in the total surface area of RBCs from 42.6 μm^2 to 42.7 μm^2 after exposure of 900 MHz RF-EMF radiation for 30 minutes. An *in vitro* study by Raoof, N. K., (2019) reported change in the morphology of RBCs due to 20 mins pulsed magnetic field (PMF) exposure at 50 Hz and intensity of 20 gausses.

In another study, Mariam *et al*., (2012) confirmed the altered shape of cell membrane and sizes of RBCs in male Balb/c mice when exposed to two types of mobile phones (Alcatel, Nokia) for longer duration. Similarly, Ali *et al.,* (2003) reported that the exposure of 50 Hz, 0.2 mT magnetic fields to animals reduce RBCs membrane's elasticity, permeability and changes the structure of hemoglobin. Ali (2007) reported a significant decrease in permeability and elasticity of RBC membrane during Magnetic Resonance Imaging (MRI), but after post MRI recovery was noticed. Rifat *et al*., (2014) reported poikilocytosis, spherocytosis, hemolysed and distorted shape of erythrocytes in *Swiss* albino mice on exposure to 10 GHz microwave (MW) for 2h/day for 30 day, which further support our experimentation. RBCs permeability due to mechanical membrane disturbance was reported on exposing RBCs to 18 GHz EMF (Nguyen *et al*., 2017). The outcome of present study confirmed that the RBCs were substantially affected by the mobile phone radiations and further reported that the extent of damage was more in 4G exposed groups. Most of the above changes normalized up to greater extent upon removal of exposure for one month (Fig.1.K&L).

Table.1: Table showing experimental design and exposure conditions.

S NO.	Groups	Exposure Conditions
1.	Control (n=6)	No exposure
2.	3G Group (n=6)	3G Mobile Phone; SAR : 0.406 W/Kg(for body); 0.562W/Kg(for head), Power Density: 0.998 mW/cm^2
3.	4G Group (n=6)	4G Mobile Phone; SAR : 0.458 W/Kg (for body); 1.520W/Kg(for head), Power Density: 1.032 mW/cm^2

CONCLUSION

We reported alteration in the shape, size and membrane of RBCs as a result of exposure to mobile phone radiation emitted from 3G & 4G cell phone on red blood signifying harmful nature of these radiations. The effect was more profound in 4G exposed group. Interestingly, most of the changes were recovered to normal after removal of exposure for 30 days. However further research is required involving other tissues of the body and to specify the time for complete recovery of exposed tissues.

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REFERENCES

Al- Shaer, A. and H. E. Kaanan (1991). Haematology.

Ali, F.M., S. Mohamed, W. and M.R. Mohamed (2003). Effect of 50 Hz, 0.2 mT magnetic fields on RBC properties and heart functions of albino rats. *Bioelectromagnetics: Journal of the Bioelectromagnetics Society, The Society for Physical Regulation in Biology and Medicine, The European Bioelectromagnetics Association*., *24*(8):535-545.

Ali, M.A. (2007). Magnetic resonance imaging and associated alteration in some biophysical properties of blood. *Rom J Biophys*., *17*(4):277-286.

Azmy, A.M. Maha, A. and A. Abd (2013). Histological study of prolonged exposure to mobile phone radiations on young male albino rats' cerebellar cortex and the role of ginkgo biloba supplementation. *Journal of American Science*., 9(11): 156-66.

Clarence, A.S., Maria, C., Rosales – Ronquillu and P.H. Silverman (1974). Scanning electron microscope observations of P. bergnei ookinetes in primary mosquito cell culture. *J. Invert. Pathol.,* 24: 179-183.

Czuprynski, C.J. and J.F. Brown (1998). 2 In Vitro Analysis: 2.1 Isolation and Preparation of Lymphocytes from Infected Animals. In *Methods in microbiology*. Academic Press., 25:189-204.

El-Bediwi, A.B., Saad, M., El-kott, A.F. and E. Eid (2013). Influence of electromagnetic radiation produced by mobile phone on some biophysical blood properties in rats. *Cell Biochem Biophys.,* 65:*297–300.*

Fadel, M., Ghanam, M., Elrefaei, F., Elgebaly, R., Abou Elela, K., Hueeein, A., Surour, D. and I. Mohamed (1994). Effect of non ionizing fields on biological membranes. *Twelfth School on Biophysics of Membrane Transport. Poland*.,62-89.

Mariam, S. A. and A. E.G. Nawal (2012). Effects of exposure to electromagnetic field on some hematological parameters in mice. *Open J Med Chem*., 2:30–42.

Mitchell Lewis, MD, FRC path, Barbara J and Imelda Bates Dacie and Pagana, KD and Pagana TJ, Mosbys 2010. Manual of Diagnostic and Laboratory Tests Louis mos by mos by Elsevier.

Ngelucci, E. A. Rittenham, G. Mclaren, C. E. Ripalti, M. Baronciani, D. Giardini, C. Alimperti, M. G. Polichi, P. and G. Lucarelli (2010). Hepatic iron concentration and total body iron stores in thalassemia major. *The New England Journal of Medicine.,*343(5): 327-331.

Nguyen, T. H. P., Pham, V. T., Baulin, V., Croft, R. J., Crawford, R. J. and E. P. Ivanova (2017). The effect of a high frequency electromagnetic field in the microwave range on red blood cells. *Scientific reports., 7*(1): 1-10.

Odaci, E. Bas, O. and S. Kaplan (2008). Effects of exposure to a 900MHz electromagnetic field on the dentate gyrus: a stereological and histopathological study. *Brain Research.,* 1238: 224-29.

Ongel, K. Mergen, H. and T. Gurbuz (2007). Approach to Electric Burn: Investigation of the literature. *DirimTıp.,*82: 369-401.

Raoof, N.K. (2019). Influence of Pulsed Magnetic field on RBCs and therapeutic action of vitamins C and E. *Journal of Advanced Pharmacy Education & Research., 9*(2):123.

Rifat, F., Saxena, V.K., Srivastava, P., Sharma, A. and R. Sisodia (2014). Effects of 10 GHz MW Exposure on Hematological Changes in Swiss Albino Mice and Their Modulation by Prunus domestica Fruit Extract. *Intern. J. of Advanced Res., 2*(2): 386-396.

Singh, H. and U. Bagai (2013). Effect of electromagnetic field on red blood cells of adult male *Swiss* albino mice. *Int J Theor Appl Sci., 5*(1):175-82.

Singh, H., Kumar, C. and U. Bagai (2012). Biological effect of electromagnetic field of VDU on immune cells of Balb/c mice. *Biological forum–An international journal*., 4(2): 82-91.

Soud, R. (2004). Human and the Environment (Education Study of the Environment) Dar Al-Hamed for Publication and Distribution," *Journal of Environmental Studies*., 1: 23- 31.

Yao, C.C., Li, X.K. and Y.X. Huang (2005). Instant effects of radiofrequency electromagnetic waveon hemoglobin in single living intact red blood cell. *Chinese Chemical Letters*., *16*(8): 1121.

Yong, J., Ruan, P. and H. Shen (2013). Monitoring the radiation injury of red blood cells to micowave radiation with different power density. *Engineering*., *5*(10):450-454.