Original Article

Mobile Phone Radiations, Possible Disruptor of Early Retinal Development

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ABSTRACT

Objective: This study was conducted with an objective to investigate the effects of mobile phone induced radiations on retinal morphogenesis of chick embryo.

Study Design: Experimental Study.

Place and Duration of Study: This study was conducted at Anatomy department, Regional Centre, College of Physicians and Surgeons Pakistan, Islamabad from Jan. 2006 to Jan. 2007.

Materials and Methods: Chicken embryos were exposed to mobile phone silent mode ringing by placing a GSM operated phone in the centre of the fertilized eggs developing in the incubator. This phone was ringed upon for 15 minutes twice daily for one experimental subgroup and 25 minutes twice for the other subgroup. The control and experimental groups were sacrificed at the end of 10 post incubation days. The retinae of the embryos were dissected out and statistically compared for the heights of different retinal layer after paraffin processing of sections.

For lower dosage (15 minutes of ringing) of mobile phone induced EMFs, thickness of the rods and cones layer and inner plexiform layer of the treated subgroup was significantly less than the control. On increasing the dosage to 25 minutes, thickness of the pigment epithelial layer of the treated group was significantly more than the control group. All the other layers were more in thickness in this subgroup but this difference was not statistically significant.

Results: The results of the study conclude that mobile phone radiations have a dose dependant regulatory effect on the early developmental process of chick embryo retina.

Conclusion: EMFs dose Mobile phone induced EMFs disrupt the developmental process of embryonal retinogenesis. This effect is influenced differently at different levels exposure.

Key words: Retina, mobile phone, electromagnetic fields.

INTRODUCTION

Debate regarding the biological effects of radiofrequency Electromagnetic fields has intensified with the storm of evolving technology and many fold increase in the daily exposure of such radiations.

Of the man made sources of Electromagnetic fields (EMFs), like radars, X rays, television, computers, anti theft devises, and simple electricity devises used at homes , the most common is the mobile telephone. Introduced back in 1940s[1] as a commercial item, mobile phones now out number land-line telephone. Increasingly larger numbers of people rely on mobile telephone technology, and health concerns about the associated EMFs exposure have been raised, particularly because the mobile phone handset operates in close proximity to the human body, and also because large numbers of base station antennas are required to provide widespread availability of service to large populations[2].

The biological effects of Electromagnetic fields have been reported in the previous researches [3]. However at present, there is insufficient data to draw firm conclusions about health effects related to EMFs exposure typically occurring in the everyday environment[4].

Base stations in residential areas[5], unconstrained usage of cell phone by all age[6] and health groups, intimate body carrying of the device[7] are some of the public concerns today.

Embryo development is characterized by multiple biological processes. Interference with these processes by any factor is the basis of teratogenesis[8].

The present study was designed to investigate the influence of mobile phone radiations on the development of chick embryo retina.

MATERIALS & METHODS

Randomly selected fertilized chicken eggs obtained from Poultry research centre were divided into two groups, treated A, and control B. The treated group A was subdivided into 2 subgroups A1 & A2 depending upon the dose of EMFs exposed to embryos. The sample number in subgroups A1, A2 and B was 30.

The fertilized eggs were placed for incubation on a double storey circular plate system This plate system was devised to accommodate 15 eggs on each plate. A GSM operated mobile phone was placed on a small rack in the centre of the lower plate in the treated subgroups. Rest of the incubation conditions were identical for the control and treated groups.

The mobile phone was rung upon twice daily for 15 minutes in case of A1 subgroup and 25 minutes in case of A2 subgroup. At the 10th post incubation day (D10)

the embryos were sacrificed, dissected out of the membrane and fixed in 10% neutral buffered formalin solution for 48 hours. The retinae were fixed *in situ.* After fixation the eyes were dissected out of the bisected head. A 0.5 cm square piece of retina with optic nerve in the centre was removed for paraffin processing. Sections cut at 5-mm thickness, and stained with hematoxylin and eosin, and showed all the retinal layers along with the pigment epithelium .The thickness and height of the retinal layers were measured, compared and analyzed using students' test considering a p value of less than 0.05 as significant.

RESULTS

The means of the heights/thickness of the individual layers of developing retina of low dose exposed subgroup A1 were compared with the means of the control group B. The thickness of the rods and cones layer and also of the inner plexiform layer of the treated subgroup was significantly less than the control (Table No.1).

The means of the heights/thickness of the developing retinal layers of high dose exposed subgroup A2 when compared with the control B showed significantly increased thickness of pigment epithelium in the treated group. Thicknesses of the outer nuclear layer, inner nuclear layer, the ganglion layer and the nerve fiber layer of the treated embryos were also more in the treated subgroup but this difference was not statistically significant (Table No.2).

Table No.1: Histological comparison of control B with low dose exposed subgroup-A1

PARAMETERS (Thickness of layers in micrometers)	SUB GROUPS				P Value
	Control B		Treated A1		
	N	Mean ± SE	N	Mean ± SE	
Pigment epithelium	29	5.123 ± 0.347	21	7.483 ± 2.393	P = 0.2597
Rods & cones layer	23	2.180 ±0.255	14	.979 ±0.078	P= 0.0010*
Outer nuclear layer	18	11.737±0.488	10	11.726±0.921	P = 0.9908
Outer plexiform layer	18	3.655± 0.298	10	3.281±0.371	P = 0.4490
Inner nuclear layer	18	73.746±4.715	10	68.080±3.365	P = 0.4151
Inner plexiform layer	26	19.396±2.544	20	10.522±1.126	P= 0.0060*
Ganglion cell layer	26	14.385±1.090	20	11.792±0.848	P = 0.0806
Nerve fiber layer	27	22.1104±2.875	21	15.492±1.784	P = 0.0744

Table No.2: Histological comparison of control B with High dose exposed subgroup-A2

PARAMETERS (Thickness of layers in micrometers)	SUB GROUPS				P Value
	CONTROL B		TREATED A2		
	N	Mean ± SE	N	Mean ± SE	
Pigment epithelium	29	5.123 ± 0.347	25	5.975 ± 0.186	P = 0.0437*
Rods & cones layer	23	2.180 ±0.255	24	2.180 ± 0.221	P = 1.0000
Outer nuclear layer	18	11.737±0.488	20	13.760±0.851	P = 0.0528
Outer plexiform layer	18	3.655± 0.298	20	3.510 ± 0.356	P = 0.7595
Inner nuclear layer	18	73.746±4.715	20	84.080 ± 4.796	P = 0.1346
Inner plexiform layer	26	19.396±2.544	25	18.665 ± 0.992	P = 0.7931
Ganglion cell layer	26	14.385±1.090	25	14.574±0.660	P = 0.8838
Nerve fiber layer	27	22.1104±2.875	25	27.176 ±3.145	P = 0.2392

DISCUSSION

This study shows the influence of mobile phone induced EMFs on the developing retina of chick embryo. When the exposure dose of EMFs was less, the radiations suppressed the development process and the retinal mile stones lagged behind the control. However when the exposure dose was increased, the stage of retinal morphogenesis was noticed to be advanced as compared to the control, highlighting a changed influence of EMFs on the retinal morphogenesis at this enhanced dose level. (Figures 1 & 2)

Mobile phones operate through Microwave electromagnetic fields (MW-EMFs) at a frequency of 900/1800 MHz at GSM system of connections. Non-thermal (low-intensity) biological effects have not been considered for regulation of microwave exposure, although numerous scientific reports indicate such effects[9]. Recently scientists have reported non-thermal effects induced by exposure to microwave

electromagnetic field (MW-EM), at a frequency level used in mobile communication, on the refolding kinetics of the heme binding site in an intracellular protein[10]. Being held near the body, usually within one wave length of the emitting EMFs, the mobile phones cast maximum field and intensity exposure.

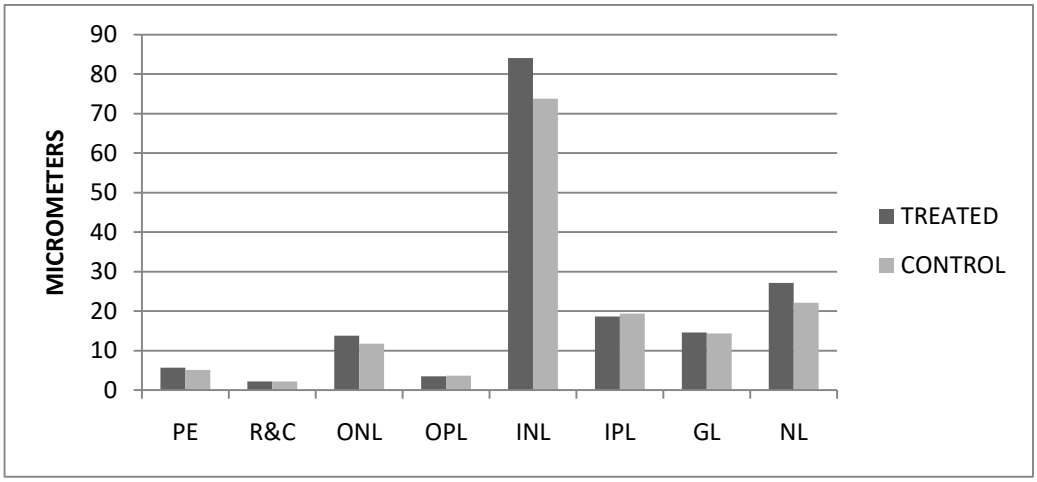

Figure No. 1: Retinal layers thickness of low dose treated subgroup-A1 compared with control B

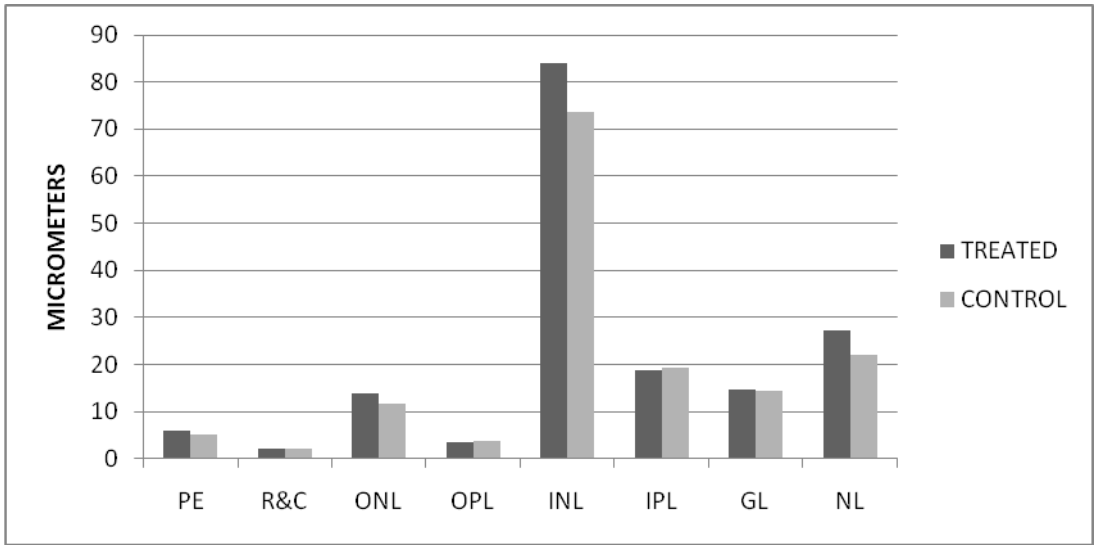

Figure No.2: Retinal layers thickness of high dose treated subgroup-A2 compared with control B2

EMFs at various frequency and intensity levels have been reported to cause different biological and health effects. The morphological differences noticed in this study as a result of different doses of mobile phone exposure can be discussed in the light of radiation induced biological effects.

Possible DNA damage and faulty repair can be a factor responsible the effects noticed in this study. DNA has been reported recently to act as fractal antenna to the EMFs. DNA appears to possess the two structural characteristics of fractal antennas, electronic conduction and self symmetry. These properties contribute to greater reactivity of DNA with EMFs in the environment, and the DNA damage could account for increases in cancer epidemiology[11].

The suppressive effects of mobile phone radiations could be due to physical interaction and interference of these currents with biological circuitry of living tissue. Also these currents can induce hormonal or oxidative stress to the developing embryos bringing about the initial growth suppression. Development is a process guided by endogenous ionic currents and electric fields. Interference of these fields through the EMFs exposure can adversely affect these events[12] hindering the normal developmental process. Electromagnetic fields of microwave frequency have been reported to can cause developmental delay of Drosophila melanogaster [13]. Electromagnetic fields, in both extremely low frequency and radio frequency ranges can also activate the cellular stress response[14]. Stress hormones although protective initially can promote damage when they are

overproduced. As is supported by recent research suggesting that increased adrenocortical and sympathoadrenal responses are associated with small size at birth [15, 16].

Pulsed microwaves have been proved to bring about oxidative stress, a possible mechanism of DNA and cell damage [17]. Studies also relate oxidative stress to delay in the embryonal development [18]. Therefore, the delayed retinal morphogenesis noticed in the A1 subgroup could be a stress response of the developing embryo to the EMFs.

The reversal of growth suppression of embryonal retina as noticed in the second half of this experiment can be discussed on the basis of the "Pre conditioning effect" of EMFs. According to this effect any external influence at first manifests its damaging effect through stress proteins. Later, intracellular over production of these same proteins can render cytoprotection[19].

The other mechanisms that might be involved in this reversal of effects on increasing the EMFs may be its direct stimulatory effect, growth factor upregulation, increased cell proliferation, cytoprotection, improved hypoxia and/or increased metabolic process, since all these factors are reported effects of EMFs.

The changed influence of mobile phone EMFs reported presently is in support of our previous study [20] in which the different levels of exposure exhibited a diverse effect on retinal pigmentation grades in a dose dependant fashion.

In addition to the radiation emission from the handset itself, researchers have to take into account the EMFs emanating from transmission antennas and mobile base station antennas.

CONCLUSION

EMFs dose Mobile phone induced EMFs disrupt the developmental process of embryonal retinogenesis. This effect is influenced differently at different levels exposure.

Keeping in view the extensive dependency of the global society on this technology, this field requires more elaborate work unraveling facts and defining safety regulations for the consumers. Casual installation of the base stations in the residential and public premises should be checked and parental awareness should be increased regarding child consumption of mobile phones.

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