

The effect of whole body exposure of 50 GHz microwave radiation on sperm counts in rats.

Yadwinder Singh & Jitendra Behari

School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India

E-mail: yadi_randhawa@yahoo.com, jbehari@hotmail.com

ABSTRACT: The objective of this study is to investigate the effects of 50 GHz microwave radiation on sperm counts, wet weights of testes and accessory reproductive organs in rats. Male rats (n = 24) of Wister strain were used in the study. Animals of age group 80-90 days were divided into two main groups- Group I Control (two subgroups of 6 rats each) and Group II Experimental (microwave exposed). The rats were housed in temperature-controlled room (20-24°C) with constant humidity (40-50%) and received food and water ad libitum. The animals were kept on 12/12-h light/dark schedule during experimental study. During exposure rats were placed in Plexiglas cages with drilled ventilation holes and kept in anechoic chamber. The animals were exposed 2 h a day for 60 days continuously at average power density 1.0 mW/cm² (SAR= 0.3 W/Kg). After the exposure period the rats were sacrificed and sperm counts determined by haemocytometer method. The sperm counts decreased significantly in epididymis of exposed animals, being 211± 6.60 x 10⁶/ml in caudal and 87± 2.09 x 10⁶/ml in caput regions as compared to control i.e. 256 ± 4.56 x 10⁶/ml (caudal) and 128± 7.77 x 10⁶/ml (caput) respectively. The one-way ANOVA test was used for statistical comparison of groups. It is concluded that exposure to these radiations may have effect on sperm counts in rats.

Introduction: - Radio frequency (rf) and microwave radiation are types of non-ionizing electromagnetic radiations present in environment and health risks posed by them have been point of debate from last two decades. As predicted earlier that primary effect of microwave radiations on biological systems is due to an increase in temperature i.e. thermal (Stuchley 1988), now non-thermal effects have also been established (Kunjilwar and Behari 1993, Paulraj and Behari 2004).

The earlier reports of Ossenkopp et al (1972) indicated prenatal exposure of pregnant rats to EMF resulted in reduction in thyroid and testis weight. Many studies have reported that MW radiation can have adverse effects on reproduction (Berman et al 1978; Lokhmatova 1994; Wegandt et al 1996; Khillare and Behari 1998; Akdag et al 1999). Earlier reports from our laboratory showed that these radiations affect cholinergic systems in rat's brain (Kunjilwar and Behari 1993), Na⁺- K⁺ ATPase activity (Behari et al 1998), growth related enzymes in rat (Paulraj et al 1999, Paulraj and Behari 2002) and protein kinase C activity in rat's brain (Paulraj and Behari 2004).

Materials and Methods: -

Animals:

Male Wister rats (n =24) with initial weights of 200-250 g were caged individually and fed with standard pellet food (Brook Bond India, Ltd.) and water ad libitum. The animals were obtained from the Jawaharlal Nehru University animal house and Institutional Animal Ethical Committee (IAEC) approved this study. The rats were divided into two main groups- Group I Control (two subgroups of 6 rats each) and Group II Experimental (microwave exposed) and were housed in temperature-controlled room (20-24°C) with constant humidity (40-50%). The animals were kept on 12/12-h light/dark schedule during experimental study. During exposure rats were placed in Plexiglas cages with drilled ventilation holes and kept in anechoic chamber.

Exposure System:

Animals were exposed in an anechoic chamber with set up of 50 GHz (Senor Microwaves, India). Adult male Wister rats were exposed 2 h a day and six days a week for 60 days continuously at power density 1.0 mW/cm² (SAR= 0.3 W/Kg). Control group of animals was kept under similar conditions except the field was not applied.

Examination of Epididymal Sperm Counts and Organs wet weights:

Total sperm counts were done as per the procedure provided by WHO. The epididymal tissue was separated into caput, corpus and caudal regions as per guidelines of Hamilton (1975). Due to insufficient amount of corpus tissue, only the caput and caudal epididymis were processed for sperm count. Caput and cauda epididymis were minced with help of scissors by keeping it in 3 ml of PBS (pH=7.4). The tissue and sperms were separated by passing the suspension through a nylon mesh with pore size 75µm. The sperm in filtrate was washed with PBS, centrifuged at 3000 rpm and then diluted in sperm count solution. Sperm numbers per milliliter were determined using a haemocytometer (Rao et al, 1993; Flores et al, 1994; Kaur and Prasad, 1994;). The total of five squares were counted in both chambers of haemocytometer and the sum of two counts is divided by appropriate factor to get the sperm concentration in millions/ml (NAFA & ESHRE, 2002).

Statistical Analysis:

Data were tested for normal distribution and then analyzed by one-way ANOVA. Differences were considered significant at probability of 5% (p<0.05)

Results and Discussion:

The present study evaluated the results of EMF exposed rats and their comparison with control rats.

Wet weights of testes and accessory sex organs:

In control rats the wet weights were 1.49±0.1 in testes, 0.39±0.01 in epididymus, 0.18±0.1 in seminal vesicle in grams/100 gram body weight of animals. In microwave exposed group no significant difference was observed in wet weights of testes but wet weights of other accessory reproductive organs reduced significantly (Table 1).

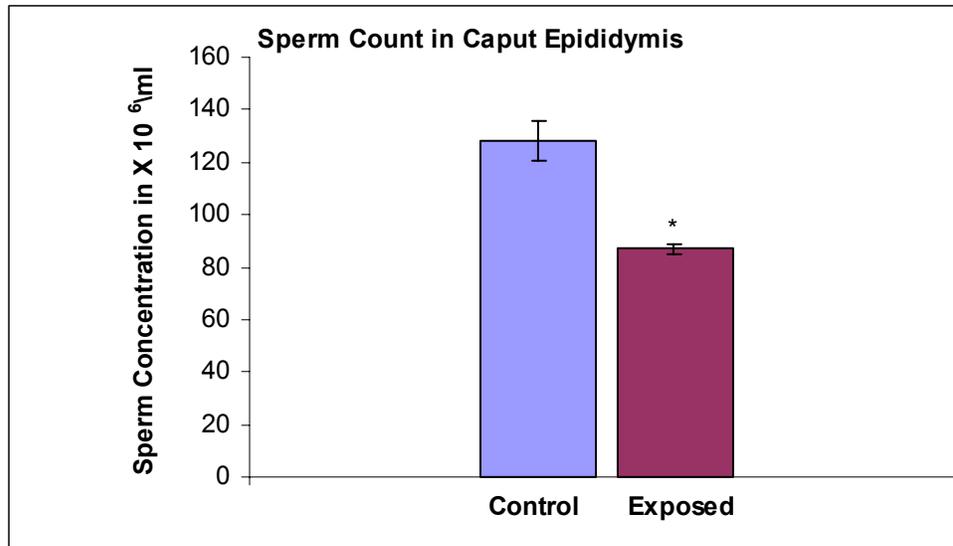
Table1: Wet weights of testes and accessory sex organs of rats after 60 days exposure to 50 GHz microwave radiation. (Values are mean ± S.D. of six rats in each group, *p<0.05)

Organ weight g /100g BW	Control	Exposed
Testes	1.49 ± 0.1	1.47 ± 0.1
Epididymus	0.39 ± 0.01*	0.30 ± 0.02*
Seminal vesicle	0.18 ± 0.1*	0.10 ± 0.01*

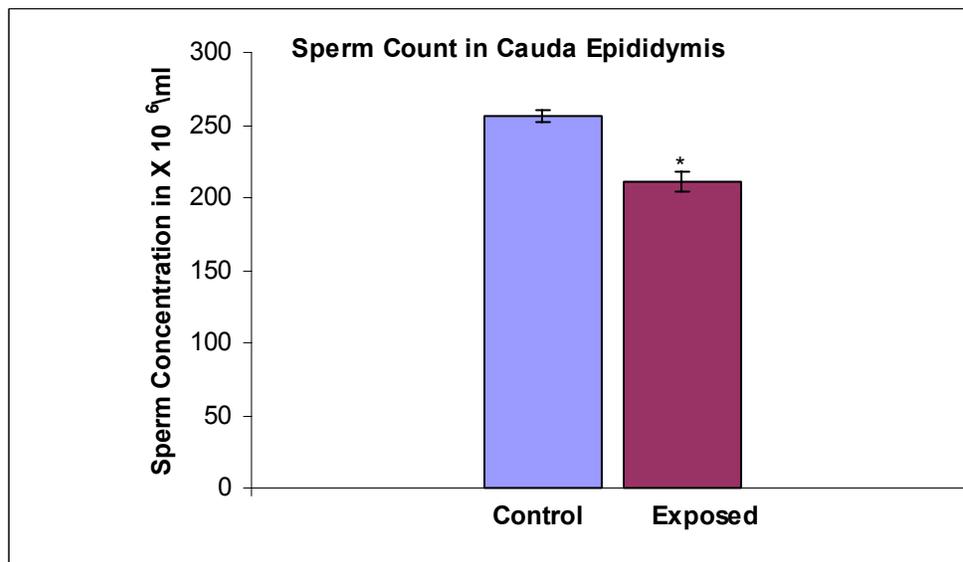
Total sperm counts:

In control rats the total sperm counts were 256 ± 4.56 and 128 ± 7.77 x 10⁶/ml in caudal and caput regions respectively. Microwave exposure caused reduction in total epididymal sperm counts in both regions significantly (p<0.05) being 211 ± 6.60 x 10⁶/ml (caudal) and 87 ± 2.09 x 10⁶/ml (caput). (Fig.1).

It is concluded that exposure to these radiations may have effect on sperm counts in rats and the whole body exposure of rats to these radiation targets spermatogenesis.



(a)



(b)

Figure 1.: Effect of 50 GHz microwave radiation on total sperm counts in caput (a) and cauda (b) epididymis of rats. Control vs Microwave exposed rats. The values are mean \pm S.D. of 6 rates. (*P < 0.05)

References:

- [1] Akdag M Z, Celik M S, Ketani A, Nergiz Y, Deniz M, Dsadag S; Effect of chronic low intensity microwave radiation on sperm count, sperm morphology and testicular and epididymal tissues of rat. *Electro and Magnetobiology* **1999**,18,133-145.
- [2] Behari J; Kunjilwar K.K.; Pyne S; Interaction of low level modulated RF radiation with Na⁺- K⁺ - ATPase. *Bioelectrochemistry and Bioenergetics* **1998**, 47, 247-252.

- [3] Berman E, Carter H.B., and House D; Tests of mutagenesis and reproduction in male rats exposed to 2450 MHz (cw) microwaves. *Bioelectromagnetics* **1980**,1,65-76.
- [4] Flores A, Kinkead T, Carboni AA, Menon M, Seethahaksimi L; Effects of sialoadenectomy and epidermal growth factor on testicular function of sexually mature male mice. *J Urol* **1994**,152,554-561.
- [5] Hamilton D W; Structure and function of epithelial lining of the ductus efferens, ductus epididymus and ductus deferens in the rats. *Handbook of physiology (eds) Green R O and Astwood E B, section 7, Endocrinology vol v, American Physiological Society, Washington DC* **1975**, pp259-280.
- [6] Kaur R, Parshad V R; Effects of dietary selenium on differentiation, morphology and functions of spermatozoa of the house rat *Rattus rattus* L. *Mutation Res* **1994**,309,29-35.
- [7] Khillare B. and Behari J; Effect of amplitude-modulated radiofrequency radiation on reproduction patterns in rats. *Electro and Magnetobiology* **1998**,17(1), 43-55.
- [8] Kunjilwar K K and Behari J; Effect of amplitude-modulated radio frequency radiation on cholinergic system of developing rats. *Brain Research* **1993**,601,321-324.
- [9] Lokhmatova S A; The effect of low-intensity prolonged impulse electromagnetic irradiation in the UHF range on the testes and the appendages of the testis in rats. *Radiat Biol Radioecol* **1994**,34,279-285.
- [10] Nordic Association for Andrology (NAFA) and European Society of Human Reproduction and Embryology (ESHRE); Manual on Basic Semen Analysis. **2002**, pp. 1-36.
- [11] Ossenkop K P., Koltek W T., Persinger M A; Prenatal exposure to an extremely low frequency, low intensity rotating magnetic field and increase in thyroid and testicle weight in rats. *Develop Pshycobiol* **1972**,5,275-285.
- [12] Paulraj R., Behari J., Rao A R; Effect of 112 MHz amplitude modulated radiation on calcium ion efflux and ODC activity in chronically exposed rat brain. *Ind. J Biochem & Biophy* **1999**, 36, 337-340.
- [13] Paulraj R., Behari J; Radiofrequency Radiation effect on Protein Kinase C Activity in rats' brain. *Mutation Research* **2004**, 585,127-131.
- [14] Paulraj R., Behari J; The effect of low level continuous 2.45 GHz wave on brain enzymes of developing rat brain. *Electromagnetic Biology and Medicine* **2002**, 21, 231-241.
- [15] Rao M V, Mehta A R, Sharma A K, Path J S, George R K; Effects of testosterone on diethylstilbesterol toxicity and comparasion to a recovery study in the rat epididymis and vas deferens. *Reprod Toxicology* **1993** 185,453-461.
- [16] Stuchley M A; Biological effects of radiofrequency fields in M.H.Repacholi(Ed) Non-Ionizing Radiations, Physical characterization, Biological effects and Health Hazard Assessment. *Proceeding for the International Non-Ionizing Radiation Workshop, Melbourne* **1988**, pp197-217.
- [17] Weyandt T B, Schrader S M, Truner T W, Simon S D; Semen analysis of military personnel associated with military duty assignments. *Reprod Toxicol.* **1996**, 10, 521-528.