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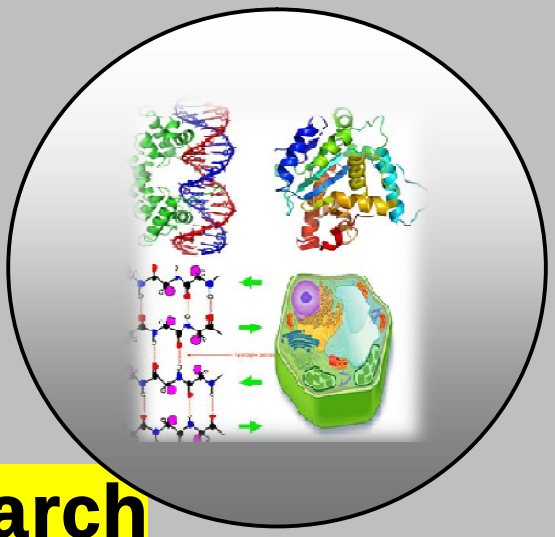

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Effect of Electromagnetic Radiation of Mobile Phone on Sperm Morphology in Albino Rats

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ABSTRACT

The technological advances are associated with progressive increase in intensity and frequency of emitted electromagnetic waves and these waves have hazardous effect on human health. Mobile phones, an essential part of our lives, are important source of these waves. The present study was carried out to see the possible effects of electromagnetic radiation on sperm morphology. Eighteen male albino rats were divided into three groups of 6 each i.e. control and two experimental groups. In experimental groups animals were exposed to electromagnetic radiation by placing a mobile phone over the cage for 5 hours per day for two months. Mobile phone was turned to answering mode for ½ hour per day in one group and 1 hr in other group. After 2 months, animals of all the groups were sacrificed and sperm morphology assay was done. In control group abnormal sperm count was 5% whereas in the experimental groups it was 39% and 56%. Different types of abnormalities observed in sperm morphology were double head, banana head, amorphous head, defective head, headless, bent neck, bent tail, double tail, defective tail and looped tail. Thus it proves that mobile phone radiation have harmful effect on male reproductivity.

Key words: Electromagnetic waves, Mobile phone, Testis and Abnormal sperm morphology

INTRODUCTION

Various environmental factors may decrease the reproductive capability of males. A hazardous effect on male fertility may be manifested by a decrease in the number of sperms, disordered motility or abnormal structure. The causative agents may be chemical substances, ionizing radiation, stress as well as electromagnetic waves. Electromagnetic waves are emitted from a number of sources out of which most commonly used are cell phones. The widespread use of mobile phones in recent years has raised the research activities in many countries to determine the effect of electromagnetic radiation emitted from it.

Concerns are growing about the possible hazardous effects of radio-frequency electromagnetic waves (RF-EMW) emitted by these devices on human health **(Markov and Kostarakis 2007).** Therefore, the present study was carried out to see the effect of electromagnetic waves on male reproductive system.

The adverse effects of RF-EMW emitted from cell phones on human and animal biological systems have been reported in the literature. Use of cell phones has been demonstrated to cause dose dependent difficulty in concentration, fatigue and headache **(Oftedal et al. 2000)**, disturbance in sleep **(Huber et al. 2000)** and changes in microscopic structure of lung, heart, kidney and liver **(Hanafy et al. 2010).** Recent studies suggest that EMW emitted from cell phones can reduce the fertilizing potential of men **(Fejes et al. 2005, Kilgallon and Simmons 2005, Agarwal et al. 2008).** In order to measure the impact of radio frequency electromagnetic waves on the human body a standardized unit called the **SAR value (Specific Absorption Rate)** was established. The SAR measures the rate of radiofrequency energy absorption in the body, expressed as watt/Kg. In INDIA upper limit of SAR allowed is 2 watt/kg.

MATERIAL AND METHODS

The present study was conducted in the Department of Anatomy, King George's Medical University, UP, Lucknow. Eighteen male albino rats weighing 200-250g were used for the present experiment. Animals were obtained from animal house of Indian Institute of Toxicology & Research, Lucknow. The rats were maintained under standard laboratory conditions in an air conditioned room and housed in polyethylene cages at temperature 22±3°C and relative humidity 30–70%. They were fed with standard pellet diet and water ad libitum. Animal care was as per Indian National Science Academy (INSA) guidelines for Care and Use of Animals in Scientific Research. The study protocol was approved by the Institutional Animal Ethical Committee (IAEC). After acclimatization for 2 weeks in laboratory conditions, animals were divided into 3 groups of 6 rats each. Group I served as control. In group II and group III, animals were exposed to electromagnetic radiation by placing a mobile phone (micromax q5, SAR - 1.87) over the cage for 5 hours per day for two months. The mode of exposure was 4½ hr in standby mode and ½ hr answering mode in group II and 4hr in standby mode and 1 hr in answering mode in group III. After 2 months, animals of all the three groups were anaesthetized by intraperitoneal administration of Nembutol (30 mg/kg body weight). Rats were sacrificed and testes were taken out along with epididymis. Sperms were obtained by mincing the epididymis in normal saline and filtering the suspension through nylon mesh. 2 or 3 drops of this was spread over the slide to fix the material. Slides were fixed with ethanol and screened for the sperm morphological abnormalities under a high power microscope. In each slide, hundred fields were studied and number of total sperms and abnormal sperms were counted. Sperms presenting the defect in shape and structure of either head or tail or both were considered as abnormal and percent incidence of the total abnormalities was calculated.

Statistical analysis was done using Analysis of variance (ANOVA) & Post-Hoc test (Tukey's HSD test).

RESULTS

It was observed that mean percentage of abnormal sperm count in control (group I) was 5.00 ± 2.10 % while 39.00 ± 4.88 % in group II and 56.00 ± 2.14 in group III (Table 1, Fig.1). The percent abnormality was found to be increased in exposed groups and this increase in group II and group III was very highly significant in comparison to control. Increase in group III was also very highly significant in comparison to group II (Table 2). Different types of abnormalities observed in the present study were double head, banana head, amorphous head, defective head, headless, bent neck, double tail, looped tail, bent tail and defective tail (Fig.2 and Fig.3).

Table 1. Mean % of Abnormal Sperm count in different groups.

SN	Group	N	Mean	SD	Minimum	Maximum
1.	I	6	5.00	2.10	3	8
2.	II	6	39.00	5.10	35	49
3.	III	6	56.00	5.14	51	63

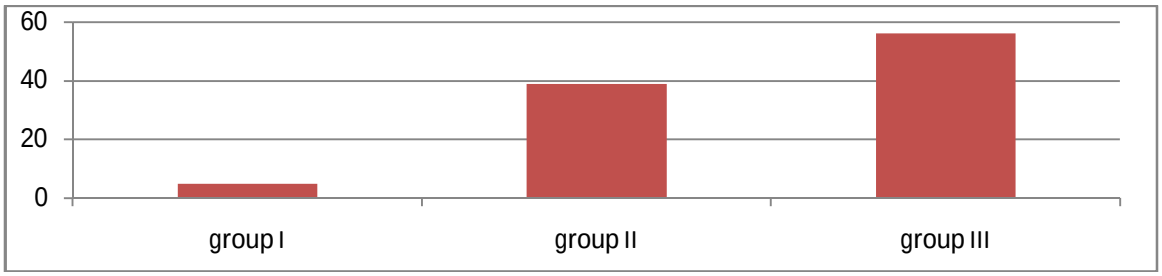

Fig. 1 bar diagram showing abnormal sperm count in control and experimental Groups.

Table 2. Between Group Comparisons of Mean % of abnormal sperm count in Animals of different Groups (Tukey's HSD).

SN	Comparison	Mean Difference	SE	"p"
1.	Group I vs Group II	-34.000	2.428	**<0.001**
2.	Group I vs Group III	-51.000	2.428	**<0.001**
5.	Group II vs Group III	-17.000	2.428	**<0.001**

DISCUSSION

In the present study very highly significant rise in the abnormal sperm count was observed after exposure to RF-EMW of mobile phone. Our findings are in accordance with **Otitoloju et al 2010 and Sahoo et al. 2010,** who also studied the effect of EMW in mice and albino rats respectively. In present study percentage of abnormal sperms in control group was 5% which is very similar to **Otitoloju et al. 2010,** who reported 2.13% abnormal sperms in control group. **Sahoo et al. 2010** reported 23% abnormal sperms in control groups**.** In present study, following exposure to RF-EMW, the number of abnormal sperms was increased and this increase was very highly significant. **Otitoloju et al. 2010 and Sahoo et al. 2010,** also reported significant increase in the percentage of abnormal sperms following exposure to EMW of base station and mobile phone respectively. In the present study, as we increased the duration of exposure by increasing the duration of answering mode from ½ hour (group II) to 1 hour

(group III) the number of abnormal sperms was further increased from 39% (group II) to 56% (group III). Similarly **Otitoloju et al (2010)** also reported increase in the number of abnormal sperms from 39.78% to 46.03% following increase in the radiofrequency radiation level. Similar findings have also been reported in human studies. **Agarwal et al (2008),** in his study on 361 men attending an infertility clinic, reported that use of cell phones decrease the semen quality in men by decreasing the sperm count, motility, viability, and normal morphology. The decrease in sperm parameters was dependent on the duration of daily exposure to cell phones. In another study on infertile male patients it was reported that decrease in normal sperm morphology was associated with the duration of exposure to the waves emitted by the GSM phone **(Wdowiak et al. 2007). Yan et al (2007)** reported an increase in incidence of sperm cell death and abnormal clumping of sperm cells in rats exposed to cellular phone in comparison to control.

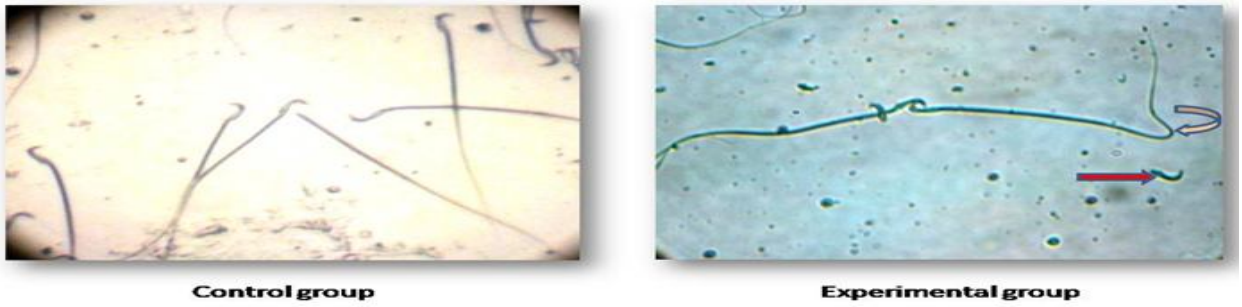

Fig. 2. Photomicrograpgic showing sperms of control and experimental groups showing: less number of sperms in experimental group, broken heads (red arrow), bent at all (pink arrow).

Different types of abnormalities observed in the present study were double head, banana head, amorphous head, defective head, headless, bent neck, double tail, looped tail, bent tail and defective tail. Similar abnormalities were reported by Sahoo et al (2010), in addition with defective head with double tail and defective tail with microcephali.

Decrease in seminiferous tubule diameter, decreased spermatogenesis and injury to Leydig cells were also studied by different authors showing the effect of RF-EMW on male reproductive system **(Wang et al. 2003, Ozguner et al. 2005)**. RF-EMR increases the free radical activity in cells **(Grundler et al. 1992).** These free radicals must be continuously removed and there are many antioxidant enzymes inside the cell to remove them. Exposure to EMR causes decrease in the activity of antioxidant enzyme activity (**Kesari et al. 2011, Desai et al. 2009**). Oxidative stress develops as a result of imbalance between free radical generation and scavenging capacity of antioxidant enzymes. Oxidative stress causes damage to DNA in nucleus and induces cell death or heritable mutations **(Aitken 2005, Panagopoulos 2011)**. The increase in abnormal sperm count may be attributed to these factors. A number of studies focused on protein alterations following EMW exposure. Changes in protein conformation in terms of folding and unfolding processes can result in either an increase or decrease in their biological activity **(Bohr et al. 2000).** Specifically, heat shock protein 70 (hsp) is one of the best examples of altered protein conformation, which was examined in various studies.

The exposure to pulsed EMW field was demonstrated to trigger cellular heat shock or stress response **(Blank 2000).** Heat shock response antagonizes the apoptotic pathways induced by EMW exposure. This antagonism results in survival of morphologically abnormal and damaged cells previously destined for death **(Desai et al. 2009).** This may also be the cause for increase in number of abnormal sperms following exposure to electromagnetic waves. The observation in this study adds to the growing evidence of the potential reproductive health effects of the constant exposure to RF-EMW.

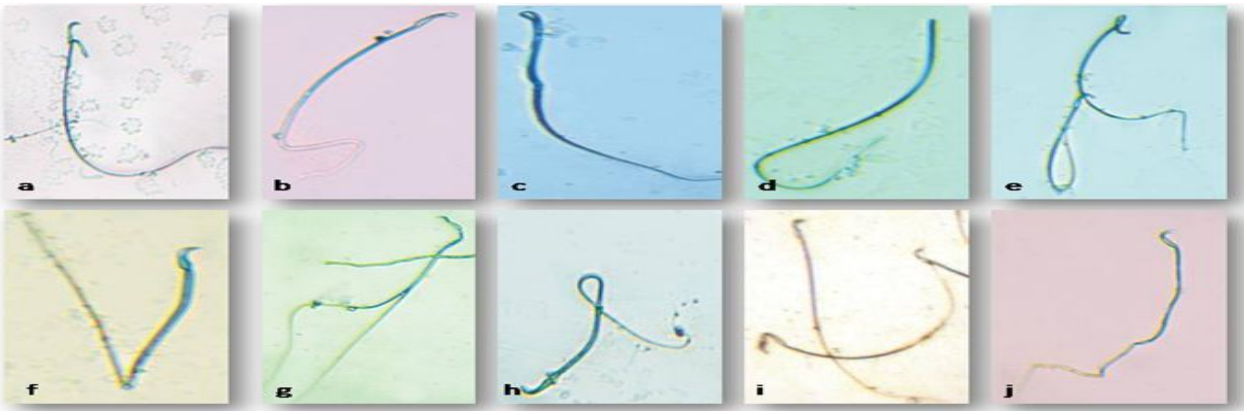

Fig. 3. Different types of sperm abnormalities: (a) double head (b) banana head (c) amorphous head (d) head less (e) bent at neck (f) bent at tail (g) double tail (h) looped tail (i) defective head (j) defective tail.

CONCLUSION

From the present study it has been concluded that electromagnetic waves of mobile phone have harmful effect on male reproductive system and these effect increase with duration of exposure.

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