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EFFECTS OF ELECTROMEGNETIC RADIATIONS PRODUCED BY CELL PHONES ON THE NUMBER AND DIAMETER OF SEMINIFEROUS TUBULES IN ALBINO RATS

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ABSTRACT

Objective: To observe the effects of electromegnrtic radiations produced by cell phones, on number and diameter of seminoferous tubules in adult albino rats.
Patients and Methods: This experimental comparative study was carried out at Institute of Basic Medical Sciences, Dow University of Health Sciences, (DUHS), Karachi, during the period from February, 2011 to October, 2011. For this study a total number of 70 adult albino rats were selected and divided in two groups A and B comprising 35 animals in each groups. Group-A served as control group whereas group-B received electromagnetic radiations emitted from conventional GSM (Global system for mobile communication) cellular phones for three hours daily for a maximum period of 110 days.
Results: A highly significant decrease was observed in the number and diameter of seminiferous tubules.
Conclusion: The results of this study shows that the exposure to electromagnetic radiations from cell phones produces histological and morphological effects on testis of adult albino rats resulting in decrease number and diameter of seminiferous tubules.

Key words: Electromegnetic radiations, Cell phones, Seminiferous tubules.

INTRODUCTION

Infertility has been recognized as a public health issue worldwide by WHO, which affects many couples of reproductive age in human population.[1,2] It is therefore, not only a medical problem but also a psychological stress, including anxiety, depression and problems in maintaining the marital relationship.[3]
It is defined as the inability to establish a pregnancy within a specified period of time, usually one year, in a couple having regular unprotected sexual intercourse.[4-6]
The major causes of infertility include chromosomal abnormalities, micro deletions, cystic fibrosis, transmembrane conductance regulator (CFTR) mutations, genetic factors e.g (follicle stimulation hormone (FSH) receptor mutation)[7-11] immunological factors, environmental factors.[12-13] Life style like smoking[14] and drinking may contribute to infertility.
In addition to the above contributing factors, there are some devices in our daily life like radio and television, which emit radiofrequency electromagnetic waves with frequencies ranging from 0.5 MHz in the AM radio band up to 30,000 MHz in radar band, also effects the fertility.15 EMF producers also include hair dryers, X-ray equipment, laboratory equipment (incubators, centrifuge), computers and surprisingly cell phones, hence increasing the chances of exposure to EMFs in our daily life.
There has been a great increase in the use of cellular phones in the past decades and concerns are emerging about the possible adverse effects by emitting EMW by these devices on human health.16 It is important to note that most of the men carry their cell phone in pocket of trousers or might clipped to their belts on waist, while using a hand-free device like blue tooth, causing

exposure of testes to more high power density cell phone radiation than a cell phone in "standby mode" in trouser pocket. Because of this reason, it is important to investigate the effect of RF EMW on male infertility.[17]

BIOLOGICAL EFFECTS OF ELECTROMAGNETIC RADIATION:

Cell phones have become important part of everyday life throughout the world. These work at different frequencies, varying according to the frequency usage in different countries. There are growing concerns about the possible hazardous effects of radio-frequency (RF) electromagnetic waves (EMW) emitted by these devices on human health. It has been reported in literature that radiofrequency electromagnetic waves emitted from cell phones have several harmful effects on human and animal biological system.[16] Potential hazardous effects of radiofrequency EMW on brain; heart, endocrine system, and DNA are extensively reported in literature, as they produce alterations in the brain electroencephalographic activity and cause sleep disturbances,[18] difficulty in concentration, headache, fatigue,[19] elevated resting blood pressure[20] and decrease production of meltonin.[21-22] Several studies with limitations in study design, suggest a possible link between cell phone use and infertility.

This study is therefore designed to see:

- To observe and compare the microscopic changes in the seminiferous tubules of control and exposed animals under the influence of electromagnetic radiation from cell phones by seeing.
- Number of seminiferous tubules.
- Diameter of seminiferous tubules.

MATERIALS AND METHODS

This experimental comparative study was conducted at the Department of Anatomy, Institute of Basic Medical Sciences (IBMS), Animal house of Dow University of Health Sciences (DUHS) and Dow Diagnostic Research and Reference laboratory (DDRL), Ojha Campus, Karachi. The research was conducted from February 2011 to October 2011 at Institute of Basic Medical Sciences, Dow University of Health Sciences (DUHS), Karachi.

Seventy adult male Wistar albino rats of 90 – 120 days were used. They were originally obtained from Charles River Breeding Laboratories, Brooklyn Massachusetts, USA, cross bred, housed and maintained on the balanced laboratory diet in DESTO, (Defence Science and Technology Organization) Karachi Laboratories, and shifted to Animal House of Institute of Basic Medical Sciences, Dow University of Health Sciences. They were kept in the plastic cages and maintained on normal circadian rhythm.

Inclusion criteria:

Seventy adult male albino rats of 90 – 120 days.

Exclusion criteria:

- Female albino rats were not selected.
- The animals of more than 120 days.
- Weight of the animals more than 250gms.
- Animals previously used for any study.
- Animals on experimental drugs.
- Animals physically not active.

METHODOLOGY

A total number of 70 adult male albino rats were selected for the study. They were bred in the animal house of Institute of Basic Medical Sciences (IBMS), DUHS, and Ojha campus and weighed with the help of the triple beam balance at the start of the study. The animals were kept in plastic cages and maintained on normal circadian rhythm. Each plastic cage contained 7 animals. They were observed for one week prior to the commencement of the study for the assessment of their health based on weight gain or loss under the natural environment, diet and water.

The animals were divided into 2 groups, the control group (A) and exposed group (B), comprising 35 animals in each group. Both the groups were further divided into five subgroups A1, A2, A3, A4 and A5 and B1, B2, B3, B4 and B5 respectively with seven animals in each group.

In each subgroup of exposed animals of "B" group, the animals were exposed to electromagnetic radiations emitted from conventional GSM (global system for mobile communication) cellular phones (1835 to 1850 MHZ) for 3 hours daily for a maximum period of 110 days (mentioned below). Each cage was provided with 8 cell phone sets in active silent mode. These cell phones were kept in a small metal cage with a wooden bottom in order to address concerns that the effects of exposure to the phones could be due to heat emitted by phones rather than to radiofrequency EMR alone. The small cages which were specially designed to keep 8 sets of cell phones were then placed in the plastic cages of rats for 3 hours for giving radiation.

All animals were sacrificed as below.

Animals of control group "A":

♣ Animals of Subgroup A1 were sacrificed on 30th day after the beginning of experiment.
♣ Animals of Subgroup A2 were sacrificed on 50th day after the beginning of experiment.
♣ Animals of Subgroup A3 were sacrificed on 70th day after the beginning of experiment.
♣ Animals of Subgroup A4 were sacrificed on 90th day after the beginning of experiment.
♣ Animals of Subgroup A5 were sacrificed on 110th day after the beginning of experiment.

Animals of exposed group "B":

♣ Animals of Subgroup B1 were exposed to electromagnetic radiation (EMR) from cell phones for three hours daily for 30 days and were then sacrificed on 30th day after the beginning of experiment.
♣ Animals of Subgroup B2 were exposed to electromagnetic radiation (EMR) from cell phones for three hours daily for 50 days and were then sacrificed on 50th day after the beginning of experiment.
♣ Animals of Subgroup B3 were exposed to electromagnetic radiation (EMR) from cell phones for three hours daily for 70 days and were then sacrificed on 70th day after the beginning of experiment.
♣ Animals of Subgroup B4 were exposed to electromagnetic radiation (EMR) from cell phones for three hours daily for 90 days and were then sacrificed on 90th day after the beginning of experiment.
♣ Animals of Subgroup B5 were exposed to electromagnetic radiation (EMR) from cell phones for three hours daily for 110 days and were then sacrificed on 110th day after the beginning of experiment.

All the animals of control and exposed group were sacrificed under deep ether anesthesia through lower midline abdominal incision extending to the skin of the scrotal sac. The scrotal sac was exposed and testes along with the spermatic cord were identified. The testes along with epididymis, ductus deferens and blood vessels were excised and routine staining was started.

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· After Hematoxylin and Eosin stain, slides were tagged arranged and later examined under light microscope to observe the number and diameter of seminiferous tubules of control and exposed animals under the influence of electromagnetic radiation from cell phones,

· Number of seminiferous tubules.

o Diameter of seminiferous tubules under light microscope with magnification of 10X objective and 8X ocular with micrometer scale. For each animal, five sections were selected. In each section, five fields were observed.

o The diameter of tubules were calculated in two axes, right angle to each other under magnification of 10X objective and 8X for ocular lens with the help of ocular micrometer.

Statistical analysis was carried out by SPSS version 16

RESULTS:

Number of seminiferous tubules:

The mean ± SD values of number of seminiferous tubules in control subgroups A1, A2, A3, A4 and A5 were 28.28 ± 0.48, 28.85 ± 1.77, 27.14 ± 1.34, 28.42 ± 1.27 and 28.28 ± 1.25 respectively as shown in table-1.

Mean ± SD values of number of seminiferous tubules of exposed subgroups B1, B2, B3, B4 and B5 were 23.33 ± 0.81, 21.71 ± 0.75, 22.42 ± 1.51, 10.00 ± 0.81 and 7.42 ± 0.78 respectively as shown in table-1.

A highly significant (P-value 0.000) decrease in the mean ± SD values of number of seminiferous tubules in exposed group was observed at 95% C.I when compared with respective control group as shown in Table-1 and Figure-1.

TABLE-1

MEAN NUMBER OF SEMINIFEROUS TUBULES IN DIFFERENT GROUPS AT VARIABLE TIME INTERVAL

Animal Subgroups(n=7)	Control group(n=35)A1-A5	Exposed Group (n=35)B1-B5	p-value
30 Days	28.28±0.48	23.33± 0.81	0.000***
50 Days	28.85±1.77	21.71± 0.75	0.000***
70 Days	27.14±1.34	22.42± 1.51	0.000***
90 Days	28.42±1.27	10.00± 0.81	0.000***
110 Days	28.28±1.25	7.42± 0.78	0.000***
Mean ± S.D	28.20±1.3	16.79± 6.99	0.000***

P Value: d" 0.05 = Significant *
d" 0.005 = moderately Significant **
d" 0.0005 = highly Significant***
e" 0.05 = Insignificant

TABLE-2

MEAN ± S.D OF DIAMETER SEMINIFEROUS TUBULES (ÌM) IN DIFFERENT GROUPS AT VARIABLE TIME INTERVAL

Animal Subgroups(n=7)	Control group A (n=35)A1-A5	Exposed Group B (n=35)B1-B5	P-value
30 Days	336.71±14.23	189.39±4.73	0.000***
50 Days	337.39±9.98	159.66±16.77	0.000***
70 Days	334.14±4.87	133.17±6.54	0.000***
90 Days	364.44±4.05	171.61±8.71	0.000***
110 Days	268.14±163.39	167.26±7.31	0.12
Mean ± S.D.	0.49 ± 0.13	0.41± 0.04	0.02*

P- Value: d" 0.05 = Significant*
d" 0.005 = Moderately Significant**
d" 0.0005 = Highly significant***
e" 0.05 = Insignificant

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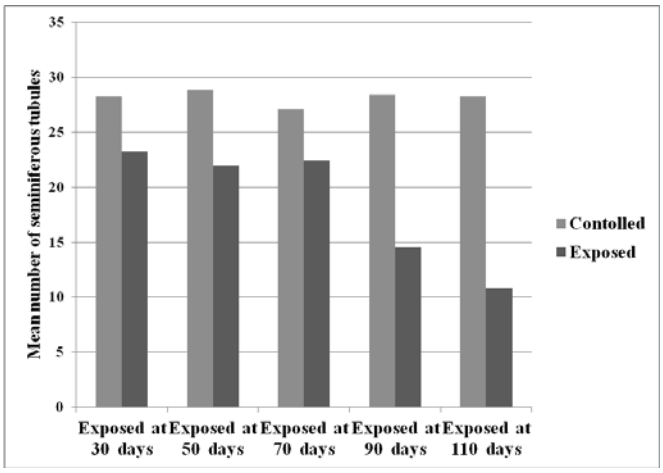


Figure-1: Comparison of mean ± S.D Number of seminiferous tubule in control and exposed groups at different time interval.

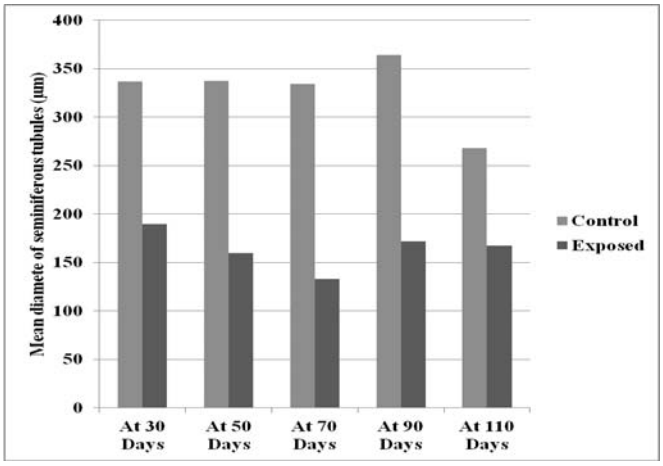


Figure-2: Mean ± S.D. Diameter of seminiferous tubules in control and exposed groups at variable time interval.

DIAMETER OF SEMINIFEROUS TUBULES:

The mean ± SD values of diameters of seminiferous tubules in control subgroups A1, A2, A3, A4 and A5 were 336.71 ± 14.23, 337.39 ± 9.98, 334.14 ± 4.87, 364.44 ± 4.05 and 268.14 ± 163.39ìm respectively as shown in table-2.

Mean ± SD values of diameters of seminiferous tubules in exposed subgroups B1, B2, B3, B4 and B5 were 189.39 ± 4.73, 159.66 ± 16.77, 133.17 ± 6.54, 171.61 ± 8.71 and 167.26 ± 7.31ìm respectively as shown in table-2.

A highly significant (P-Value 0.000) decrease was observed in the mean ± SD values of the diameters of seminiferous tubules of exposed groups at 95% C.I when compared with respective control groups as shown in Figure-2.

DISCUSSION

Majority of living species are exposed to wide range of radiation from natural and artificial (man-made) sources excessive exposure can result in ill health effects, depending upon level and duration of exposure X-rays and CT scans, for diagnostic and therapeutic purposes are beneficial for patients but involve a health risk, including cancer One of the most important advancement in the recent era is the development of mobile or wireless telecommunication. Wireless technologies such as cellular/ cordless phones, cell phone towers and Wi Fi transmitters have added greater convenience to our lives, in addition to some health risks.

More than 4 billion people are using microwave transmitters (cellular/ cordless phones) for minutes or even hours everyday.23 In addition to above, individuals use wireless, laptops, personal data assistance (PDA) and pagers in their work places, public spaces, home and schools.

It is important to consider the possible adverse effects that might arise by the use of these advance technologies. People exposed everyday to non ionizing radiation experience symptoms, causing a serious consideration globally. The health issues correlated to the use of cell phone hand set were impairment of short-term memory, headaches, brain tumors, other cancers, sleep disturbance, depression, tiredness, neuroendocrine functions, miscarriages and semen quality impairment.[24]

The sterility in the couples of reproductive age group is found to be 15% and going to rise in recent decades.

A significant decrease in concentration as well as total volume of sperm with no known cause (defined as Idiopathic Infertility) has been noticed.25-26 It is however, supposed to relate that type of male infertility to worldwide increase in the levels of non-ionizing radiation. As epidemiological studies encounter various limitations, it is assumed that laboratory investigations including animals would be more suitable to rule out radiation effects on spermatogenesis.

The present study, focused on NUMBER AND DIAMETER OF SEMINIFEROUSTUBULES of the rat testis when exposed to EMR from cell phones for different intervals of time, has found that radiofrequency electromagnetic radiations had adverse effects on testes of albino rats.

Present study showed a significant decrease in number of seminiferous tubules in exposed subgroups when compared with respective control subgroups. Atrophy in seminiferous tubules as well as disintegration and fusion between some seminiferous tubules were observed in the current study. Presence of vacuoles between spermatogenic cells was also observed, that may be due to the degenerating changes in response to the electromagnetic radiation from cell phones. These findings were also observed in a study by Khayyat, in which microscopic examination of testis of mice exposed to radiation for 8 hours for a period of 3 days indicated some changes in both interstitial tissue and seminiferous tubules. Interstitial tissue showed proliferation while disorganized and degenerating seminiferous tubules were also noticed. In animals exposed to radiation for 8 hrs for 12 days to EMF, marked alterations were observed. Most of the seminiferous tubules disintegrated or irregular in shape with a break in their continuity. In addition, atrophied seminiferous tubules and fusion between tubules were noticed.27 Study by Salama, included 24 rabbits, also supported these findings. Histological examination of radiation exposed testis showed a decrease in number of seminiferous tubules.28

The diameters of seminiferous tubules were measured under light microscope and the mean values of diameters of control groups

when compared with diameter of seminiferous tubules of respective exposed groups, showed a highly significant decrease in the diameter. The diameters of seminiferous tubules and mean height of germinal epithelium were significantly decreased in EMF group ($P< 0.05$), in a study by Ozguner M, where radiation was given by means of a radiofrequency generator, with frequency ranging between 869-894MHZ. Testicular morphological alterations may possibly be due to hormonal changes.29 In their studies, Dasdag, Zulkuf et al and Dasdag,, Ketani et al. also supported this finding. They found a significant decrease in mean diameters of seminiferous tubule in rats when they were exposed to electromagnetic radiation from cell phones ranging between 890-915MHZ. The duration of exposure was 3 minutes per day for 30 days.[30-31] This was also observed by Rajaei et al. who mentioned that exposure to EMF for long period could decease the diameter of reproductive ducts and length of epithelial cells.[32]

CONCLUSION

The results of the present study concluded that exposure to EMR from cell phones produces histological and morphological effects on testis of adult male albino rat, resulting in decrease in number and diameter of seminiferous tubules.

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