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The Effects of Cellular Phone Towers Radio Frequency Electromagnetic Radiation (RF-EMR) on the Fertility of Wistar Rat Males

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ABSTRACT

The aim of the present study was to evaluate the safety of living nearby cell phone towers which emit Radio Frequency-Electromagnetic Radiation (RF-EMR) through *in vivo* study and what is the risk of these radiations on fertility hormones (FSH, LH and PRL) and histopathological changes of testes of Wistar male rats. A 28 days old male rats 35 - 54.2 g of body weight, were used. Rats were exposed to RF-EMR emitted by cell tower base station in Khartoum State. The rats were divided into four different groups. Control animals that were kept without exposure to any RF-EMR. The rats were in the other three groups exposed for 8 weeks to RF-EMR at: 57nw/m^2, 37nw/ m^2, and 10nw/m^2. The exposure to radiation was on daily basis for 10 hours at temperature 30–33ºC. Fertility hormones viz: FSH, LH and PRL were estimated. Exposure to RF-EMR caused significant decrease in the weight of testes of experimental rats in all groups. Also had significant increase effects on PRL however there was significant decrease in FSH and LH in all groups of rats exposed RF-EMR when compared with the control group. Histopathological examination of testes among groups exposed to RF-EMR showed various changes. Most seminiferous tubules of testis of male rats exposed to RF-EMR (57nw/m^2) showed polymorphism, necrosis in the germinal epithelial cells, hypertrophy and degeneration of spermatogonia cells, interstitaial oedema, and absence of sperm. While those exposed to RF-EMR (37nw/m^2) showed deceleration of spermatogemesis, vaculation of leyding cells, started atrophy of spermatids cells and haemorrhages. Sections of testis of male rats exposed RF-EMR (10nw/m^2) showed shrinking of some seminiferous, oedema, hyperplasia and vaculation of spermatocytes, blood vessels dilated, fibrosis of tunica, fusion between some seminiferous tubules. It could be concluded that exposure to RF-EMR emitted from cell tower does represent a significant risk factor for rat reproductive system.

INTRODUCTION

In the recent past, people living in vicinity of cell towers have raised the issue of adverse health effects of RF radiation emanating from cell towers which causes harmful thermal and non-

thermal health effects. Exposure to high level of non-ionizing radiation emitted by base stations has been recognized to cause variety of diagnostic entities which manifest as diffuse hypersensitivity syndrome not easily recognizable (Hutter *et al.*, 2006). Electromagnetic fields (EMF) and radio frequency radiation (RFR) interact with human tissues and may have adverse effects on fertility and reproduction, and may cause negative effects on sex organs. Damage to these organs results in unorganized hormones which must be produced or regulated by such endocrinal organs. Such changes can have an almost immediate effect on fertility and also damage off spring which may take several generations to show up (Goldsworthy, 2007).

Infertility is defined as inability to conceive after a year of sexual intercourses without the use of contraceptives (Claman, 2004). Decrease in male fertility is a phenomenon which occurs within years, which may suggest that one of the reasons in the effects of the development of techniques in the surrounding environment (Sheiner *et al.*, 2003). In the literature, the harmful effects of RF-EMR on male reproductive system are shown in some studies. Cao *et al*., (2009) studied the relationship between physical and biological effects of alternating magnetic field on reproductive function of murine testis. They found that magnetic field, either strong or weak, may damage the testis function by including injury to seminiferous tubules and leyding cells. Dasdag *et al.,* (2003) reported the decrease in seminiferous tubule diameter in male rats testes after exposure. They used commercially available 890-915GSM with 0.14W/Kg whole body SAR. Moreover, Wang *et al.,* (2003) confirmed a decrease in serum testosterone in the exposed group with EMW in comparison to the controls. The aim of the present study was to evaluate the significance of living near cell phone towers by determining the RF EMR affection in vivo on studying the alteration of follicle stimulating hormone (FSH), luteinizing hormone (LH) and prolactin (PRL) hormone and histopathological changes of testis gland of male Wistar rats.

MATERIALS AND METHODS

Twenty four Wistar albino male rats were used in this study; these rats were obtained from the animal house at Faculty of Pharmacy Khartoum University. They were kept in plastic cages to adapt for 7 days before starting the experiments. The cages dimensions were 30×20×22cm. The rats were fed by special diet containing carbohydrates, proteins and vitamins. The male rats were from the age of 4 weeks old. Their weight ranged between 35.0 to 54.2 g. They were exposed 8 weeks to radio frequency (RF) electromagnetic radiation emitted by cell tower base station on the roof of one house in south Gebra / Khartoum State. The rats were divided into 4 groups six rats each in separate cage as follow: G0: Control, animals were kept without exposed to any RF EMR,G1:animals were exposed to RF-EMR (57nw/m^2) at distance 3 meters from the tower,G2:animals were exposed to RF-EMR (37nw/m^2) at distance 10 meters from the tower. G3: animals were exposed to RF-EMR (10nw/m^2) at distance 20 meters from the tower. The radiation was emission for 8 weeks with daily period of 10 hours at night (8 PM to 6AM), at temperature 30-33ºC. At the end of

experiments(lasting 2 months), rats were weighted, anatomized, blood samples were collected from pericardial puncture by using syringe size 5mm and put into EDTA tubes. Serum was prepared by centrifugation of the blood for 15 min at13000 r/min and kept at -20ºc till analyzed. Fertility hormones (Follicular Stimulating Hormone FSH, Luetinizing Hormone LH and Pro Lactine Hormone PRL) tests were estimated using Enzyme Linked Immuno Sorbent Assay (ELISA) kits (Biotek made in USA).

For histological study, testis were removed, weighted then placed in10%formal saline to 24 hours then taken and processed for paraffin embedding. After that tissue sectioned by microtome at5µm then the sections of tissue were prepared and mounted on glass slides. Haematoxylin-eosin stain was used. General structure and pathological changes were studied and photographs were taken using light microscope provided with digital camera.

The data considered changed in the testis weight, alteration of FSH, LH and PRL and histological changes of testis. These data were presented as mean values± standard deviation (SD). Differences among the four groups in the experiment were analyzed by the one-way analysis of variance (ANOVA).The accepted level of significance was set at $p<0.05$.

RESULTS

A significant decrease of mean testes weight in all groups (G1,G2 and G3) of young male rats exposed RF-EMR compare to control(1.83 ± .35 gm) ranged between .63± .05 gm in G1 to .71± .11 gm. in G3 are shown in Fig(1) P<.05=.00 Table(1).

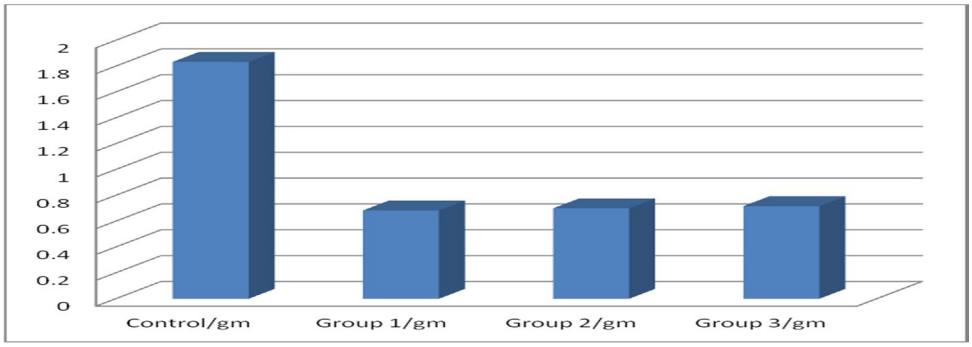

Figure 1: Mean weight of testis of young male rats exposed to RF EMR Compared with control

Table 1: P value of mean weight testes of young male rats exposed to RF EMR Compared with control

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.783	3	1.928	37.252	.000
Within Groups	1.035	20	.052		
Total	6.818	23			

Mean serum levels of PRL hormone in all groups of young male rats exposed to RF-EMR showed significance increase levels compared to the control (P =0.000).The mean level of PRL of group 1 which exposed to 57nw/m^2 RF EMR is too high (5.32±.75 µ/ml) (Figure 2).

Significance reduction in mean level of FSH was detected in all groups of young

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male rats exposed to RF- EMR (P=0.00) ranged from 0.34 ± 0.31 ml U/ml in group 1 which exposed to 57nw/m^2 RF EMR to 1.00 ± .47 ml U/ml in group 3 which exposed to 10nw/m^2 RF EMR in comparison with control (2.1± 0.84 ml U/ml) (Figure 2).

Comparison of mean serum level of LH in control group with that of exposure young male rats with RF-EMR proved significant reduction (p=.006). The mean level of LH decreased with increase in exposure of RF-EMR (Figure 2).

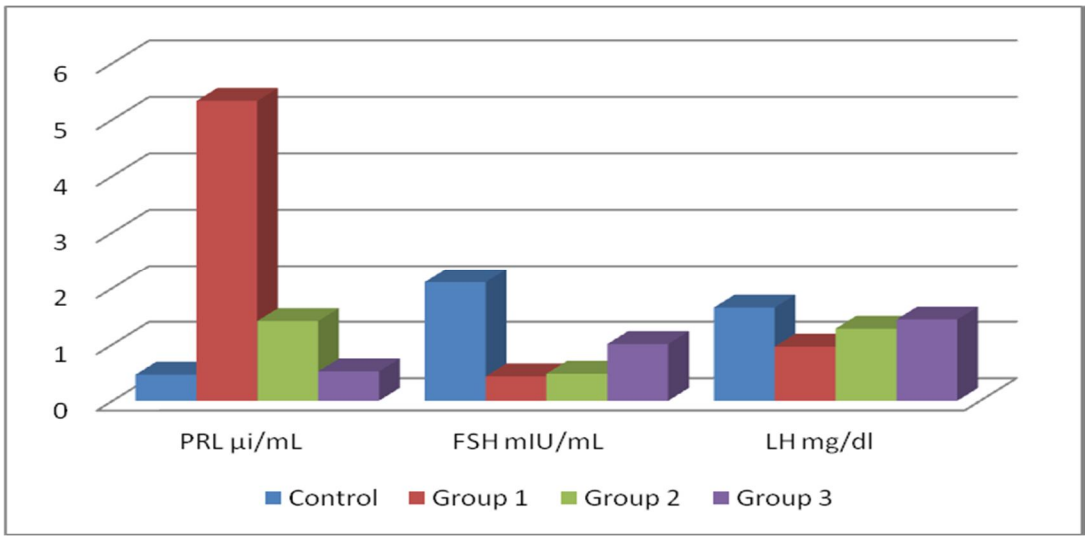


Figure 2: Mean serum levels of PRL, FSH and LH hormones of young male rats exposed to RF EMR Compared with control

Histopathological changes in testes: The microscopic investigation of control group testis showed that there was normal surrounding by a fibrous capsule, seminefrous tubules were normal, spermatogenesis was normal and it was contain arranged spermatids, mature sperms in the lumen, tubules are lined with seminiferous epithelium consisting of two cell types spermatogenic and sertoli cells and intertubular connective tissue holds the tubules with each other and contains blood vessels also leyding cells (Plate 1). Histopathologicl examination of testes among groups of male rats exposed to RF EMR showed various changes. Most seminiferous tubules of testis of male rats exposed to RF EMR (57nw/m^2) showed necrosis in the germinal epithelial cells of seminiferous tubules,hypertropothy and degeneration of spermatogonia cells, polymorphism of seminiferous tubules,interstitaial edema, absent of sperm in the lumen of tubules and some tubules are empty (Plate2). Sections of testes of male rats exposed to RF EMR (37nw/m^2) showed deceleration of spermatogemesis, vaculation of leyding cells, started atrophy of spermatids cells and haemorrhages (Plate 3). Transverse sections of testis of male rats exposed RF EMR (10nw/m^2) showed shrinking of some seminiferous and edema, hyperplasia and vaculation of spermatocytes, blood vessels dilated (varicoceles) and fibrosis of tunica albuginea, fusion between some seminiferous tubules, disorganization and necrotic spermatogenic Plate (4).

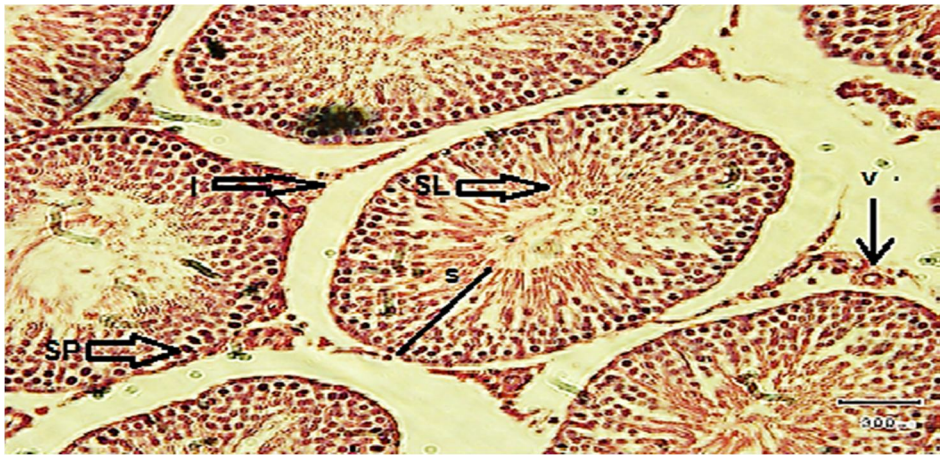


Plate1: Transverse Section of testis of control group of male rats(10×20) shows normal appearance of spermatogenesis, seminiferous (S), intertubular tissue (I), spermatogonia (SP) cells, sperm in the lumen (SL) and blood vessels (V) (H&E)

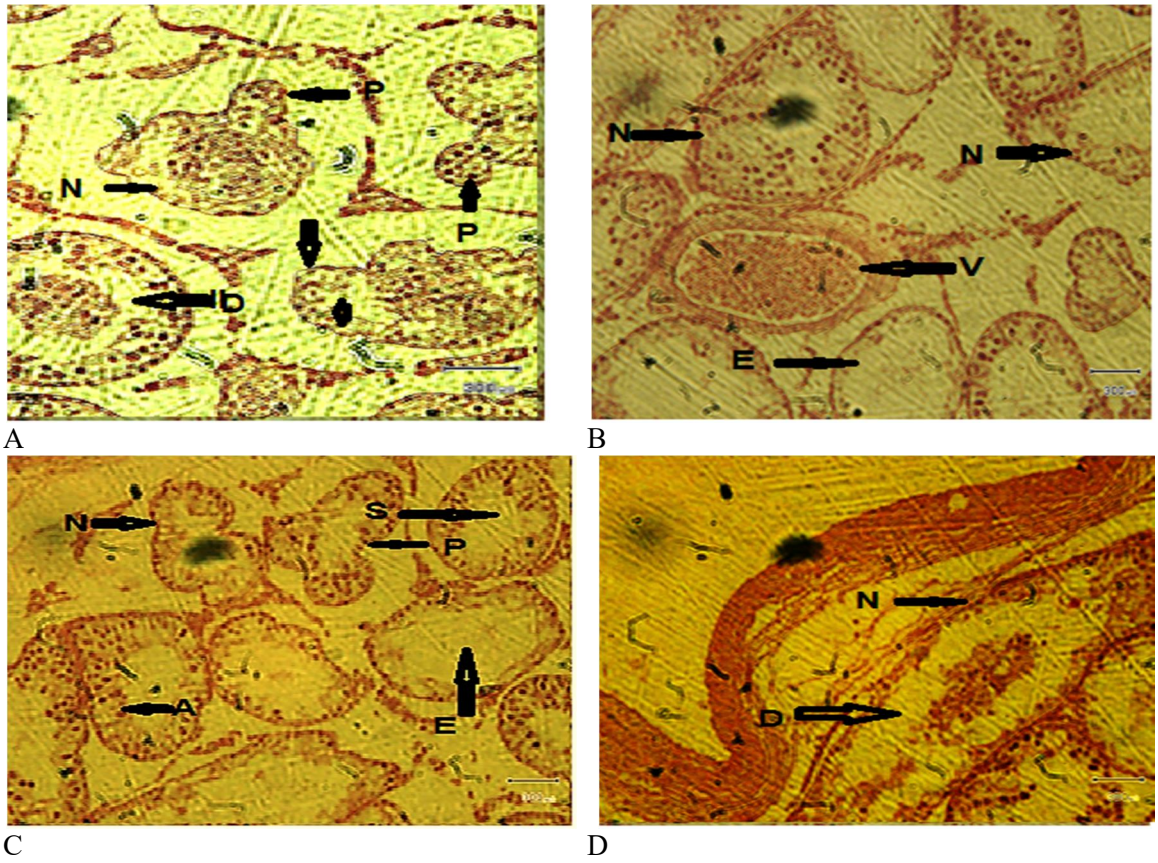
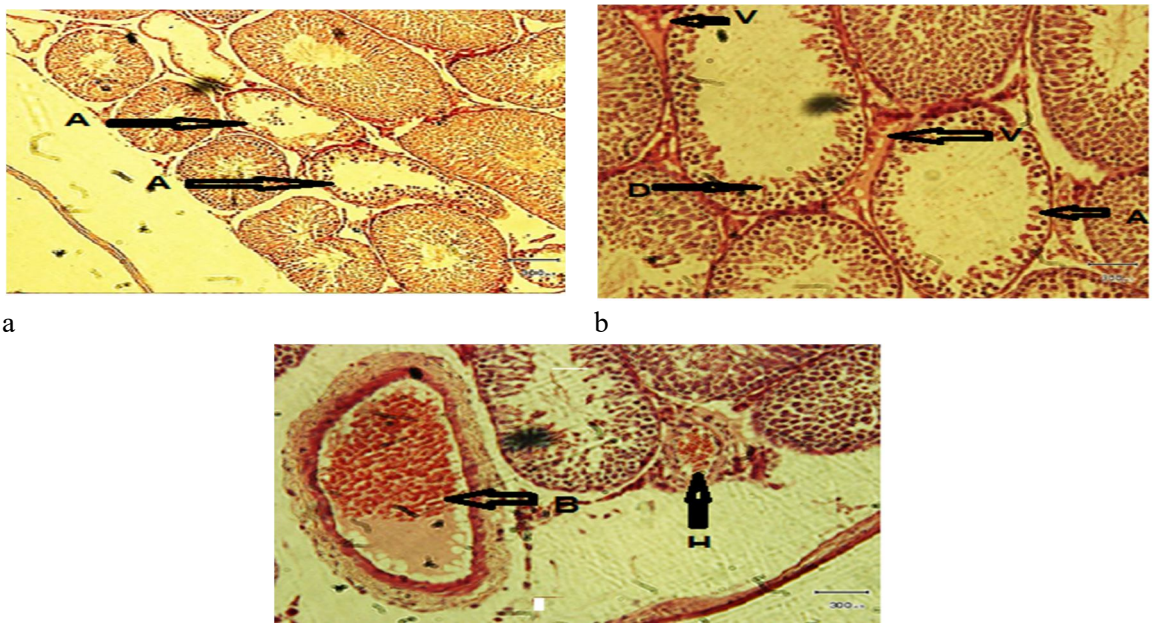


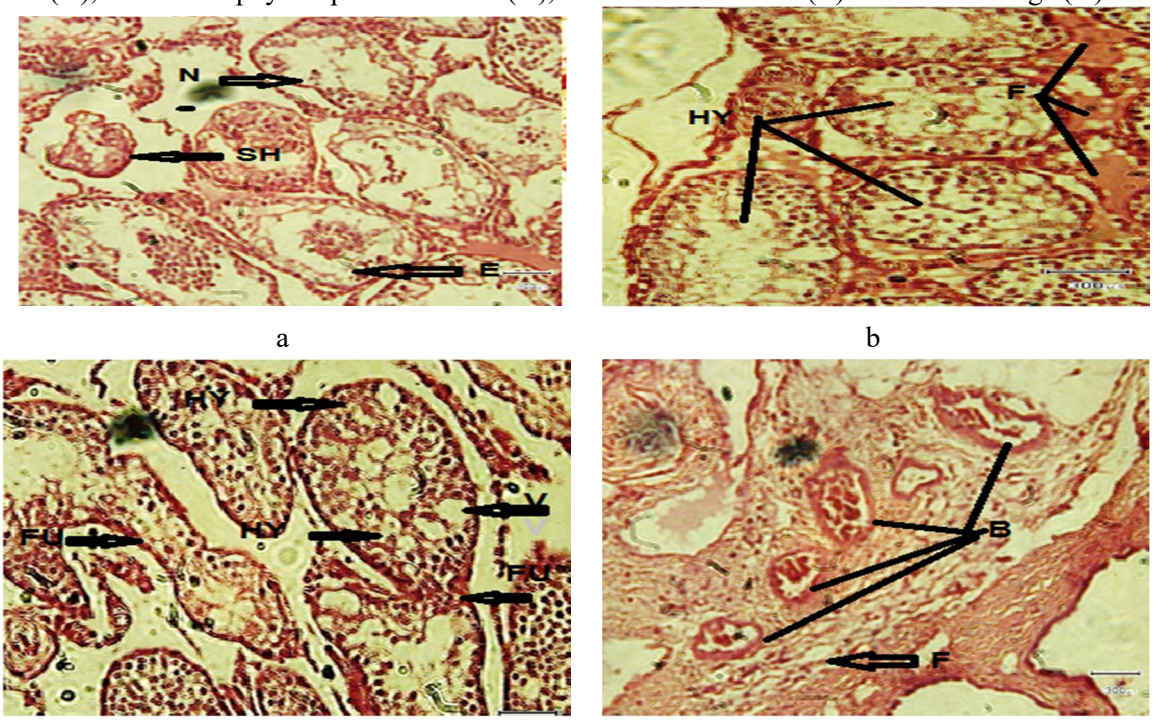
Plate 2: Transeverse section of testes of male rats exposed to RF EMR (57nw/m^2) (10×20) shows necrosis in the germinal epithelial cells (N), atrophy and degeneration of spermatogonia cells (A), polymorphism of seminiferous tubules (P), intertubuler edema (D), absent of sperm in the lumen of tubules (S), some tubules are empty (E) and blood vesicle dilated (v) (H&E).



a b

c

Plate 3: Transeverse section of testes of G2 of male rats exposed to RF EMR (37nw/m^2)(10×10) in a and (10×20) in b & c shows deceleration of spermatogemesis (D),vaculation of leyding cells(V), started atrophy of spermatids cells(A),dilated blood vessels (B) and haemorrhage (H).



a b

c d

Plate 4: Transeverse section of testis of G3 of male rats exposed to RF EMR (1o nw/m^2)(10×10) in (b) and (10×20) in a, c & d shows shrinking of some seminiferous (SH), oedema (E), hyperplasia (HY) and vaculation (V) of spermatocytes, blood vessels dialated (B) , fibrosis of tunica albuginea (F) and interstitial tissues, fusion between some seminiferous tubules(FU), disorder and necrotic spermatogenic (N))(H&E).

DISCUSSION

In the present investigation, results showed a significant decrease of testes weight in all groups of young male rats exposed to RF-EMR range from $10nw/m^2$ to $57nw/m^2$ compare to control. These agree with Hong *et al*., (2003) who confirmed a reduction in testicular weight and deformity in sperm when mice exposed to 50 Hz for 2 - 4 weeks. Behari and Kesari (2006) confirmed that mobile radiation exposure of 900MHz frequency for 35 days at 2 hours per day of male rats had caused significant decreases in the sperm count and testes weight. However, these present results are in contrast with that reported by Al-Akhras *et al*., (2006) who treated adult male rats to50 Hz magnetic field for 18 weeks and reported no significant effects on the weight of testis of the exposed rats.

Furthermore, and with reference to hormonal effects, the result of the present study detected a significant increase in PRL level and a significant decrease in FSH and LH levels in all groups exposed to RF EMR in comparison to control. This result agrees partially with Gutschi *et al*., (2011) who detected lower LH levels and no change in FSH and PRL values when human exposed to cell phone emission. On the other hand Al-Akhras *et al*., (2006) reported no significant on serum levels of FSH but there was a significant increase in the levels of LH when they treated male adult rats to 50 Hz sinusoidal magnetic field after 18 weeks. Our suggestion is that RF EMR causes effects on hypothalamus and pituitary gland, then on the releasing hormones. This suggestion agrees with Baharara *et al*., (2004) who reported that radiation emitted from mobile phones can alter levels of LH through influencing central nervous system(CNS) and changes in the secretion of gonadotropin- releasing hormone (GnRH).

In histological examination, the testes of male rats exposed to($57nw/m^2$) RF EMR showed necrosis in the germinal epithelial cells of seminiferous tubules; hypertrophy and degeneration of spermatogonia cells; polymorphism of seminiferous tubules; interstitial edema and lacking of sperms. These agrees with Yan *et al*., (2007)who found a significant higher incidence of sperm cell death and abnormal sperm clumping in rats exposed to cellular phone emissions. Also in agreement with Khaki *et al*., (2006) who reported that exposure to EMF caused changes in the shape of seminiferous tubules and their boundary tissue. Similarly, Ai and Soleimany (2008) confirm that exposure of rats to an electromagnetic field reduced the number of primary spermatocytes. Another study by Ozguner *et al*., (2002) found a decrease in germ cells in testis when rats exposed to EMF for 2 h every day for ten days. The present results also agree with Khayyat (2011) who observed severe changes in the testis of animals exposed for 12 days to EMF, presented by the inter-tubular space became wider accompanied by damage in the epithelium germinal layer and irregular shape of seminiferous tubules .Cao *et al.,* (2009) reported that magnetic field at 1000 Hz or 2000 Hz may damage the testis by inducing injury to seminiferous tubules and leyding cells and necrosis of spermatogenic cells in the lumen. Greenhall and Vessey (1991) reported that hypospermatogenisis associated with hormonal dysfunction, congenital germ cell deficiency due to exposure to heat and radiation. EMR

may alter leyding and sertoli cells function, leading to decreased hormone secretion which may lead to altered cell proliferation as reported by Roosli *et al*., (2007). The findings of the present study are in contrast with some studies for example Ribeiro *et al*., (2007) who found that low intensity pulsed RF does not impair testicular function in adult rats when they are exposed to RF emitted from a conventional GSM cellular telephone for one hour per day over eleven weeks.

In addition to the above confirmation of different study's findings, the present study add another histopathological effects to testes of rats exposed to RF-EMR range from10 nw/m^2 to 57nw/m^2. These were varicoceles in all groups which defined as abnormally dilated vein. A varicoceles resulted from an increase of testicular temperature results in damage of the spermatogenic function of the testes (Jung and Schuppe, 2007).These case play an important role in testicular dysfunction due to Lerchl *et al*., (1993).

CONCLUSIONS

The results of the present study demonstrated that exposure to10 nw/m^2 - 57nw/m^2 RF-EMF during child life of male rats have adversely effects on the structure and function of testes in adulthood. Indicating that detrimental effect of RF- EMF on developmental period is irreversible and may lead to subfertility or infertility in adulthood. These summarized on:

1. RF EMR causes significant decrease in weight of tests of experimental rats .
2. RF EMR has significant effects on some sexual hormones example PRL.FSH and LH of young male rats.
3. Histological studies proved significant effects of the testes exposed RF EMR and these may lead to primary infertility.

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