

Full Length Research Paper

The influence of 950 MHz magnetic field (mobile phone radiation) on sex organ and adrenal functions of male rabbits

M. R. Sarookhani*, M. Asiabanha Rezaei, A. Safari, V. Zaroushani and M. Ziaeiha

School of Public Health, Qazvin University of Medical Sciences, Bahonar Blvd, Qazvin, Iran.

Accepted 2 November, 2010

Mobile phones are used frequently and held close to the body thus they are potentially dangerous sources of electromagnetic (EM) radiations. The clear effects of EMF (electromagnetic field) on many organs of the body have not been known until now and have puzzled scientists. The objective of this study was the evaluation of the influence of different powers (3 and 6 W) of 950 MHz magnetic field on testosterone, FSH (follicle stimulating hormone) and cortisol levels of male rabbits. The study was conducted on 18 male rabbits with an average weight of 1400 to 1700 g. The exposure period of simulated mobile phone radiations (950 MHz; 3 and 6 W) was 2 h/day for 2 weeks. Blood was taken from the animals and FSH, testosterone, and cortisol levels of sera were assayed and compared with the control group. The results showed a decrease ($P < 0.05$) in the concentration of testosterone in both 3 and 6 W groups. In the 6 W group, FSH concentration increased (compared to 3 W) but decreased in comparison to the control group. There were no differences in cortisol levels in any group. Results consequently suggest that testosterone and FSH levels are disturbed as a result of mobile phone exposure and it possibly affects reproductive functions. However, cortisol concentration as a marker of adrenal gland function was not affected.

Key words: Mobile phone, 950 MHz EMF, rabbits, sex organ, adrenal function.

INTRODUCTION

An electromagnetic field (EMF) consists of electrical and magnetic parts. The electrical part is produced by a voltage gradient but the magnetic part is generated by any flow of current and is proportional to the current actually flowing through the lines which depend on consumer demand. Both types of fields have biological effects, but the magnetic field is more damaging since it penetrates living tissues more easily (Goldsworthy, 2007).

Over the past century, a vast and growing spectrum of man-made EM fields have been introduced, with the most popular kind being the mobile phone EMF. Because mobile phones are held close to the body and are used frequently, these devices are potentially the most dangerous sources of EM radiation that the average

person possesses.

In effect, the whole body can act as an efficient antenna to pick up EM radiation. There is little doubt that signals transmitted by a mobile phone, even if it is a hands-free type, will reach all parts of the body and penetrate living tissues more easily thus, the effects of EMF occur at the cellular level (Goldsworthy, 2007). Because of its common position (waist belt) the nearest organs to mobile radiations are sex organs and adrenal glands. Damage to these organs results in unorganized hormones which must be produced by or regulated by such endocrine organs. Such changes can have an almost immediate effect on fertility and also damage offsprings which may take several generations to show up (Gladwoethy, 2007).

A lot of experiments have been done in relation to the effects of EMF on the endocrine system. It is reported that magnetic fields cause increases in hormonal secretions such as glucagon, cortisol and thyroxin in rats

*Corresponding author. E-mail: sarookhani2002@yahoo.com.

Table 1. Detection limit and CV% of intra- and inter- assays of the kits used in the study.

Parameter	Kit		
	Detection limit (analytical sensitivity)	Inter-assay CV%	Intra-assay CV%
FSH	0.2 IU/L	6.3	2.6
Cortisol	10 nm	9.2	5.9
Testosterone	0.025 ng/ml	15	14.8

Table 2. Comparison of average levels of hormones and statistical analyses in the three study groups.

Hormone	Group		
	Normal	3 Watt	6 Watt
FSH	57.4 ± 12.23	58.4 ± 3.57	78.667 ± 5.81
Cortisol	442.80 ± 84.58	450.00 ± 153.0	422.33 ± 114.73
Testosterone	12.020 ± 2.82	1.640 ± 0.80	0.667 ± 0.38

Data are presented as mean ±SD.

(Gorczyńska and Wegrzynowies 1991). Cortisol, a hormone excreted from the adrenal gland is a stress indicator and it has been recognized that its level is elevated in humans exposed for a long time to EMFs (Vangelova et al., 2007). Other studies did not reveal this effect (Dgeridane et al., 2008). Evidences of the detrimental effect of mobile phones on male fertility are still equivocal as studies have revealed a wide spectrum of possible effects ranging from insignificant effects to variable degrees of testicular damage (Agarwal, 2007).

In animal models, it was shown that the diameter of seminiferous tubules and the mean height of the germinal epithelium of rat testes tissues were significantly decreased but there was an insignificant decrease in plasma LH (luteinizing hormone) and FSH levels in EMF exposed group compared to control group (Ozgunner, 2005). The biological effects of EMF emitted from mobile phones are a current debate and still a controversial issue.

Studies performed on male sex organs and adrenal gland hormones are scarce and therefore future studies with a careful design are needed to determine the effect of cell phone use on these organs. This paper examined the changes in testosterone, FSH and cortisol due to different intensities of 950 MHz magnetic field, produced by cellular phones.

MATERIALS AND METHODS

This is a basic experimental study which was conducted on 18 white New Zealand male rabbits with average weights of 1400 to 1700 g. The rabbits were obtained from a known (Razi Institute, Iran) breeding unit and housed per cage in a well ventilated room (25 ± 2°C) with 12 h light and dark cycles at the animal house where they were regularly fed on a standard diet. The exposure system was a radiation chamber designed and calibrated in Khajeh Nasir Toosi University, Tehran, Iran with a monopole antenna producing magnetic fields of 3 and 6 W (power intensity during

speaking) sources which mimicked actual fields originating from mobile phones (Khavanin et al., 2007; 2008). Each test group was exposed to 950 MHz EMF of 3 or 6 W intensities 2 h per day for 2 weeks (Khavanin et al., 2007; 2008).

After exposure, the tests and control groups were anesthetized and blood samples were collected directly from the heart. Sera were obtained and stored in a deep freezer at -20°C until used. The cortisol, testosterone and FSH concentrations in the sera were determined by Sensitive Radio Immuno assay (RIA) Kits (Immunotech, Beckman Coulter Co. Prague, Czech republic). The detection limits and coefficients of intra- and inter- assay variations of these kits are shown in Table 1.

The data were statistically analyzed using SPSS Version 16 Software. For comparison of between group variations, ANOVA test was performed. Statistical significance was set at P<0.05.

RESULTS

The average of measured parameters (testosterone, FSH and cortisol) and the comparison of results of the statistical analyses in the 3 groups (control, 3 W and 6 W) are shown in Table 2. The results show that the concentrations of testosterone and FSH after exposure in both 3 and 6 W groups are decreased compared to the control group. When the 6W group was compared with the 3 W group, the concentration of testosterone was decreased in the 6 W but the concentration of FSH increased (P<0.05). None of the groups showed changes in cortisol levels (P<0.05; F=0.08).

DISCUSSION

Results of this study suggest that testosterone and FSH levels were disturbed as a result of mobile phone EMF exposure which can possibly affect reproductive functions. Preliminary studies, though with limitations in study design, suggest a possible link between cell phone

use and infertility. Signals transmitted by a mobile phone, even if it is a hands-free, will reach all parts of the body, including sex organs. Seminiferous tubules are the place for the production of spermatocytes. It is possible that EMFs can damage these tubules. Studies conducted by Ozguner et al. (2005) on male rats showed that the diameter of seminiferous tubules and the mean height of the germinal epithelium were significantly decreased after 900 MHz EMF exposure (Ozguner et al., 2005). FSH is responsible for the activation of the seminiferous tubules, resulting in the production of sperm as well as the conversion of testosterone to estradiol (Carl et al., 2006). In the 3 W power group of the test animals, the concentration of FSH decreased compared to the control group which could be a factor for decreased activation of seminiferous tubules.

Testosterone which is formed in the Leydig cells, also acts on seminiferous tubules and stimulates spermatogenesis. This androgenic hormone exerts negative feedback effects on gonadotropins at the hypothalamic and pituitary levels (Carl et al., 2006). The 3 W power exposure group of the present study showed a decreased concentration in testosterone as well. It is possible that low concentration of FSH could result in decreased concentration of testosterone in this group. Conversely, in comparing the 6W with the 3W group, the level of testosterone was decreased in the 6 W exposed group whereas the concentration of FSH increased. Such alterations could presumably be explained by the negative feedback effects. However, a recent study found that the use of cell phones adversely affects the quality of semen by decreasing sperm counts, motility, viability, morphology and DNA damage (Agorwal, 2007; Philips et al., 2009). In this research, semen analysis was not performed. Anyway, evidences of the detrimental effect of mobile phones on male fertility are still equivocal, as studies have revealed a wide spectrum of possible effects.

Cortisol as a representative glucocorticoid is produced in the Zona fasciculata of the adrenal cortex and is needed in times of stress to maintain blood glucose levels and prevent shock. Cortisol regulates its own secretion by a negative feedback effect on the hypothalamic-pituitary axis (Carl et al., 2006; Pamela and Richard, 2007). It has been shown that temperature is an important factor in the regulation of endocrine hormones' release (Squires, 2003). Microwaves especially EMF of cell phones can produce temperature and energy in living tissues (Hirata et al., 2002). Cortisol is a stress indicator that is produced in response to such stimulants. However, the duration of exposure to EMF is a significant factor. In this study in which the animals were exposed to 950 MHz EMF for 2 weeks, no differences were observed compared to the control group. In Aghdam et al., (2008) study which was conducted on Syrian hamsters exposed for 10 days (short term exposure), no differences were observed in cortisol levels but in the 50 days-exposure group (long term exposure), the hormone concentration increased

dramatically. In human model studies, it was recognized that cortisol levels of physiotherapists as well as nurses showed a significant increase in long term electromagnetic fields exposure (Vangelova et al., 2007). In another human model study, there were no alterations in the concentration and circadian patterns of steroid (cortisol and testosterone) hormones in 20 male volunteers ex-posed to EMFs through the use of a cellular phone for 2 h/day, 5 days/week for 4 weeks (Dgeridane et al., 2008).

Other conflicting studies have also been published regarding hormonal disturbances as effects of EMFs emitted by cellular phones. To deal with the uncertainty regarding this issue, it is recommended that further high-quality researches be performed both in animals and humans (Yasmina et al., 2008; Sadeghi et al., 2006; Akhras, 2006).

ACKNOWLEDGMENTS

This work was financially supported by Qazvin University of Medical Sciences, Qazvin, Iran under Grant No. 9721. We also thank members of the Hematology and Occupational Health Laboratories of Qazvin University for their contributions.

REFERENCES

- Agarwal A (2007). Cell Phones and male infertility: dissecting the relationship. Available on: www.rbmonline.com/article/2923.
- Aghdam H, Lotfi AR, BahoJb M, Karami AR (2008). Effects of electromagnetic fields of cellular phone on cortisol and testosterone hormones rate in Syrian hamesi. *Int J. Zool. Res.* 4(4): 230-233.
- AL Akhras A, Homa D, Ahmed E (2006). Influence of 50 MHz magnetic field on the testosterone and other fertility parameters of adult male. *Bioelectromagnetics*, 27: 127-B10.
- Carl AB, Ashwood ER, Bruns DE (2006). *Tietz text book of clinical chemistry and molecular diagnostics*. Eds., Elsevier/Sanders, St. Louis, MO. pp. 191-218.
- Dgeridane Y, Touitou Y, De Seze R (2008). Influence of electromagnetic fields emitted by GSM-900 cellular telephones on the circadian patterns of gonadol, adrenal and pituitary hormones in men. *Radiat. Res.*, 169(3): 337-43.
- Goldsworthy A (2007). The biological effects of weak electromagnetic fields. Available on: www.goldsworthy-bio-weak-em-0.7.doc. 1-15.
- Gorczyńska E, Wegrzynowies R (1991). Glucose hemostasis in rats exposed to magnetic fields. *Inves. Radial.*, 26: 1095-1100.
- Hirata A, Wantanabe H, Shiozawa T (2002). SAR and temperature increase in the human eye induced by obliquely incident plane wave. *IEEE Trans. Electromagnetics*. 44(4): 592.
- Khavanin A, Zaroushani V, Mortazavi SB, Rezaei A, Mirzaei R (2008). Comparison of antioxidant capacity changes in rabbit blood after disconnected exposure to mobile phone microwave. *J. Sabzevar Sch. Med. Sci.*, 14(4(46)): 238-245.
- Khavanin A, Zaroushani Y, Mortazavi SB, Mirzaie R, Hassani J (2007). Investigation of biological effect of microwave mobile phone on antioxidant in rabbit blood. *Inranian J. Basic Med. Sci.*, 4(32): 244-249.
- Ozguner M, Koyu A, Cesur G, Ural M, Ozguner F (2005). Biological and morphological effects on the reproductive organs of rats after exposure to electromagnetic field. *Soudi Med. Z.*, 26(3): 405-10.
- Pamela CC, Richard AH (2007). *Lippincott's illustrated reviews: Biochemistry*. Lippincott Publisher. 3rd edition.
- Philips JL, Singh NP, Laib H (2009). Electomagnetic fields and DNA

damage. *Pathophysiology*, 16: 79-88.

Sadeghi H, Zare S, Hayatgeibi H, Alivandi S (2006). Biological effect of power frequency magnetic fields on serum biochemical parameters in guinea pig. *Pak. J. Biol. Sci.*, 9:1083-1087.

Squires EJ (2003). *Applied animal endocrinology*. 1st ed. UK: CABJ pub. ISBN 0-85199-594-2.

Vangelova K, Israel M, Velkova D, Ivanova M (2007). Changes in excretion rates of stress hormones in medical staff exposed to electromagnetic radiation. *Environmentalist*, 27: 551-555.

Yasmina D, Yvan T, De Seze R (2008). Influence of Electromagnetic Fields Emitted by GSM-900 Cellular Telephones on the Circadian Patterns of Gonadal, Adrenal and Pituitary Hormones in Men. *Radiat. Res.*, 169(3): 337-343.