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MOBILE PHONES AND MALE REPRODUCTIVE FUNCTION (BRIEF REVIEW)

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Mobile phones are arguably the most rapidly adopted and widespread technology in human history. The number of mobile phone subscriptions, a proxy for mobile phone users, has been steadily increasing since the 1990s.

Mobile phones are a source of nonionizing electromagnetic radiation in the radio frequency range. As shown by increasing number of biological, clinical and epidemiological studies, the radiations emitted by mobile telephony, at levels that people are daily exposed, are highly bioactive producing a variety of effects on living organisms. Nonionizing electromagnetic radiation in the frequency range of mobile phones may cause nonthermal biologic effects, many of which might be relevant for human health. For example, mobile phone technology has been linked to several neurophysiologic effects [15], an increased risk for some tumors [19, 26]. Possible mechanisms for adverse effects include genotoxic effects [4, 21, 27] and cellular stress responses [5, 22].

It is important to note that many men carry their cell phones in a trouser pocket (or clipped to their belts on waist) while using a hands-free device such as Bluetooth. This technology exposes the testes to more high power density cell phone radiation than a cell phone would in the "Stand by mode" in a trouser pocket. Due to this reason, investigating effect of radiofrequency electromagnetic waves on male fertility is also important.

In this article, we review the effects of radiation emitted by mobile phones on male reproductive system.

Recent epidemiological studies investigated the possible effects that electromagnetic radiations have comparing mobile phone use and sperm quality of the individuals. Fejes I. et al. suggested the effects of electromagnetic fields radiated by mobile phones using *in vivo* experiments [17]. This study concluded that prolonged use of mobile phones might have negative effects on sperm motility characteristics.

Wdowiak A. et al. performed another retrospective study involving 304 men of reproductive age and noted that there was a significant decrease in the percentage of sperm cells with normal forward progressive motility in correlation with the frequency of cell phone usage. In this study, 65,7% of patients without cell phones had over 50% of sperm with forward progressive motility whereas only 17% of patients who frequently (regular phone use for more than 2 years) used cell phones had over 50% of sperm with forward progressive motility [28].

Agarwal A. et al. carried out an observational study of 361 men to determine whether there is a correlation between cell phone usage and sperm morphology. Men were divided into four usage groups: no use, < 2 h/day, 2-4 h/day, and > 4 h/day. The authors reported about decreased sperm count, motility, viability, and morphology with increased use [6].

However, epidemiologic studies might have many uncontrolled factors in the environment of these studies, which may reduce the reproducibility of their results.

Some investigations were conducted *in vitro* to evaluate effect of mobile phone radiation on sperm motility, viability and morphology [8, 12, 20]. Their results indicate significant decrease in sperm motility and viability as well as abnormal sperm morphology.

Falzone N. et al. reported negative effect of mobile phone radiation on fertilization potential [25]. Significant reduction in sperm head area and acrosome percentage of the head area, a decrease in sperm binding to the hemizona were observed after exposure to 900-MHz mobile phone radiation at specific absorption rate of 2,0 W/kg. While acrosome reaction was not affected.

Agarwal A. et al. exposed 32 neat semen samples to electromagnetic radiation. The authors showed a significant increase in reactive oxygen species levels coupled with a decrease in total antioxidant capacity, compared to the unexposed group. It was concluded that radiation emitted from mobile phones can lead to an increase in oxidative stress in human spermatozoa yielding decreased motility and viability characteristics [12]. Induction of oxidative stress in rat's testis and epididymis was observed in investigation performed by Mailankot M. et al. [23]

In an animal studies controversial results were received. Salama N. et al. showed a significant decline in the sperm count after 8 weeks of exposure of rabbits to electromagnetic radiation via cell phones and decrease in motility after 10 weeks [24]. Similar results were received in Mailankot M. et al. study [23]. Kesari K.K. et al. noted a decreased mean value of total sperm count, and an increased mean percentage of apoptotic cells in rats [18]. In contrast, some studies did not show a correlation between mobile phone electromagnetic radiation and alteration in sperm count [10, 16, 29].

Many experimental researches assessed histological changes in testes due to mobile phone radiation.

Some reports [3, 24, 29] showed a decrease in the diameter of seminiferous tubules and epithelial thickness. Al-Damegh [1] has demonstrated that 14 days electromagnetic radiation exposure causes

degenerative changes and high levels of mitotic division. The sections show degeneration in the seminiferous tubules with the complete absence of spermatozoa, and some spermatogonic nuclei also show karyomegaly and a high incidence of mitotic divisions. In the experimental group, the diameter of the seminiferous tubules was significantly increased compared with the normal unexposed rat testicular architecture, whereas the mean height of the germinal epithelium was significantly decreased. A reduction in the spermatid numbers within the lumen of the seminiferous tubules, marked mitotic divisions and pyknosis of some spermatogonic nuclei were observed.

While, no significant differences were observed by histological evaluations between rats that had and had not been exposed to electromagnetic radiation in research performed Celik S. et al. [2], Ribeiro E.P. et al. [11], Forgacs Z. et al. [13, 14].

But, electron microscope analysis performed in Celik S. et al. [2] investigation revealed that the membrana propria thickness and the collagen fiber contents were increased and the capillary veins extended in the experimental group. Common vacuolization in the cytoplasm of the Sertoli cells, growth of electron-dense structures, and existence of large lipid droplets were noted as the remarkable findings of this study.

From mentioned above we conclude that there are many controversies between results of animal studies. Moreover, from many points of view the rat is an inadequate model of man in the study of non-ionizing radiation effects on the testis: its dimensions are much smaller, its scrotum is non-pendulous and its testes migrate freely through the inguinal canal between the abdomen and scrotum [30]. Usually rats are used because of their ready availability, but difference in body size, geometry and physiological responses mean that extrapolation of these results to man is not straightforward and any such comparison should be made with great caution.

Testes perform two important functions: spermatogenesis and steroidogenesis. Both are regulated by pituitary gland through production luteinizing hormone and follicle-stimulating hormone.

We found only one study devoted to effects of mobile phone radiation on structure of pituitary gland. Fang et al. [9] showed progressive derangement in rats' pituitary glands exposed to high level of electromagnetic radiation in form of swollen mitochondria as well as dilatation of Golgi complex and diffusive lysosomes. With increasing duration of exposure mitochondrial vacuolization, formation of myelin figures, distinct dilatation of endoplasmic reticuluum, occurrence of numerous secondary lysosomes, and clustering of heterochromatin under the nuclear membranes could be observed.

It is known that interstitial cells (of Leydig) in testis secrete testosterone, which has the regulatory role in stimulating and maintaining sperm production.

Wang S.M. et al. [7] revealed edema and vacuolation, swelling of cytoplasmic mitochondria, reduce of lipid droplets, pale staining of most of lipid droplets, and partial or complete cavitation of lipid droplets in Leydig cells of male Kunming mices within 28 days after electromagnetic radiation.

Lack of information about structure of other organs of male reproductive system (prostate, seminal vesicles, etc.), pituitary gland and hypothalamus as major endocrine regulators under mobile-phone radiation suggests the need for more research in this area.

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Кутя С.А. Мобільні телефони та репродуктивна функція у чоловіків (короткий огляд) // Український медичний альманах. – 2012. – Том 15, № 6. – С. 232-234.

У статті проаналізовано результати досліджень, присвячених вивченню структурних змін органів репродуктивної системи у чоловіків та функціональних особливостей сперматозоїдів під впливом електромагнітного випромінення мобільного телефону. Визначені перспективні напрямки у цій області.

Ключові слова: випромінення мобільного телефону, репродукція, чоловіки.

Кутя С.А. Мобильные телефоны и репродуктивная функция у мужчин (краткий обзор) // Український медичний альманах. – 2012. – Том 15, № 6. – С..232-234.

В статье проанализированы результаты исследований, посвященных изучению структурных изменений органов репродуктивной системы у мужчин и функциональных особенностей сперматозоидов под действием электро-магнитного излучения мобильного телефона. Определены перспективные направления в этой области.

Ключевые слова: излучение мобильного телефона, репродукция, мужчины.

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Article reviewed effects of mobile phone radiation on structure of male reproductive organs and sperm function. Perspectives in this field are determined.

Key words: mobile phone radiation, reproduction, men.

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