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Effect of Mobile Phone Radiations on Male Fertility: An Update

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ABSTRACT

For many decades, male infertility due to unknown aetiology remains an unresolved issue that includes factors such as environmental changes and lifestyle factors. Male fertility is affected when the exposure to radiations and other hazardous substances were intense. Radiations have a drastic detrimental effect on the process of spermatogenesis inside the testis. This current update review mainly focuses on the effects of mobile phone radiation, which may contribute to the cause of male infertility. Exploration into various studies done by researchers showed the detrimental effect of radiofrequency radiations on male fertility when exposed over a longer period. Many studies proved that the radiofrequency electromagnetic field (RF-EMF) affects male fertility by enhancing irretrievable changes in semen parameters. Some studies also disprove the above. The current update review will give a helicopter view of different findings and hypothesis stated by various authors. Further, an elaborated study on the effect of mobile phone radiations on male fertility was already started in the institution.

Key Words: Male Infertility, Radiations, Hazards, Mobile phone, Radiofrequency radiations, Semen parameters

INTRODUCTION

Infertility had become one of the disorder that affects nearly 15% of couples of which 7.5% involves male infertility.¹ Male infertility had turned to be an up to date downside problem because of abnormal semen characteristics. The semen quality has deteriorated in recent years worldwide. The majority of infertile or sub-fertile male showed either immotile sperm and/or DNA damage.² The impact of mobile device radiation on male fertility is that the subject of recent interest and investigations.³ Cell phones are widely used among all age group people particularly adults and it's been noticed that people use them for long hours for various purposes. These phones emit radiofrequency electromagnetic waves (EMW), a low-level radiofrequency (RF), at a frequency that ranges between 800 and 2200 MHz.⁴ Men carry mobile phones in their pockets or in holders which are designed close to their procreative/reproductive organs. Thus, it's vital to predict the consequences of cell phone hazards on male fertility. Although several recent epidemiological studies have updated that prolong use of mobile phones could play a role in male infertility.^{5,6} Mobile phones would possibly influence the genital systems

via EMW thermal and non-thermal effects and that they could interfere with normal spermatogenesis and end in a significant decrease in semen quality.⁷⁻⁹

Electromagnetic fields and mobile phone radiations

Radiation will be characterized into ionized and non-ionized radiations. The non-ionizing radiations are of two forms: 1) Extremely low frequency (ELF) electromagnetic fields (EMFs), and 2) Radiofrequency (RF) EMFs - which are produced by wireless radio waves/microwaves products.¹⁰ The frequencies within the range of 100 kHz to 300 GHz refer to RF and represent solely the vicinity of the electromagnetic spectrum. The source of radiofrequency electromagnetic field (RF-EMF) exposure affects the semen parameters. The advanced technology of intermediate frequency had become another source of exposure to electro-magnetic fields. This specific frequency range falls between the low frequency (low frequency- 0.1 Hz–1 kHz) and the radio frequency (RF) (10 MHz–300 GHz).⁷ Harmful EMW emitted from cell phones could interfere with normal spermatogenesis and end up in a significant decrease in semen quality. Electro-

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magnetic waves will have an effect on reproductive function through both thermal and non-thermal effects.⁷

Epidemiological and experimental studies on mobile phone radiations

Many studies showed the damaging effects of RF-EMR on Leydig cells, seminiferous tubules, and specifically, the spermatozoa were clearly defined.¹ Though RF-EMR reduces androgen (testosterone) levels, impairs spermatogenesis and causes sperm DNA damage¹¹, the connection between RF-EMR devices and male infertility remains polemical. The negative effects of cell phones on sperm parameters in 361 male is detected.¹¹ Similarly, Fejes et al.⁶ showed the correlation statistics between the daily mobile phone usage duration and semen quality in 371 male. There are two more reports available that also added up the effect of cell phones on sperm motility in humans.^{6,12} Epidemiologic studies reported that mobile phone use has associations with some semen quality parameters, but the findings across these research studies are not entirely consistent and standard for all the examined semen parameters.^{12,13.}

Many epidemiological and experimental studies have reported that RF-EMWs have potential adverse effects on human health. They will interfere with nervous system function and cause headache, fatigue, impaired cognitive function, sleep disturbances and an increased risk of tumour^{14,15}; it also affects the cardiovascular system and thus increases resting blood pressure.¹⁶ Recent epidemiologic (cross-sectional or prospective) studies have highlighted the role of mobile phone exposure on sperm motility, morphology and viability, suggesting a drastic reduction in male fertilization potentiality.²² These studies examined the relationship of mobile phone use and its impact on semen parameters and concluded that mobile phone use could cause a decrease in fertility.¹⁷

Mobile phone radiations and male fertility

Various studies have stated the effect of mobile phones on semen parameters. In one of the study, it has been proved that the semen parameters were abnormal when the mobile phones are carried in the pocket near the testicles.¹⁸ Similarly; Fejes et al.⁶ have suggested that the habit of carrying a mobile phone in pockets and speaking durations were negatively correlated with sperm count. In another study, Agarwal et al.¹¹ had reported that as mobile phone usage duration keeps increasing, the quality of sperm decreases. In controversial to the above two reports, Mehmet et al. did not find any effect on the semen profile due to prolonged mobile phone usage and the habit of carrying a mobile phone in their pockets near testicles.¹⁹

Effect of RF-EMF exposure on sperm parameters:

Prolonged mobile phone usage has been found to decrease

the progressive motile sperm count, motility and viability along with an increase of reactive oxygen species (ROS) which leads to abnormal sperm morphology.^{20,21} Recent studies added up that that Wi-Fi from laptops and computers may negatively affect sperm quality.²² EMF is found to be responsible for the decrease in fertilization rate²³, reduced sperm count due to triggered apoptosis,^{24,25} reduced sperm quality²⁶, hormonal changes within the testis^{6,11}, developmental impairments in the embryonic period.^{27,28} Radio-frequency electromagnetic field exposure from mobile phones or alternative sources of microwaves adversely result in the decrease of the male fertilizing potential of spermatozoa. Many authors found that carrying mobile phones within the trouser pocket or on the belt pouches reduces sperm motility.^{29,30} Kesarri et al. demonstrated that males who use mobile phones for longer duration exhibit inflated rates of abnormal sperm morphology.³¹

The exposure to RF-EMF resulting in male reproductive organ pathologies including a decrease in sperm quality is probably due to oxidative stress so increasing free radical levels or superoxide ends up in a decrease in sperm motility and viability that is triggered by inflated concentrations of superoxides.²¹ Free radicals oxidize the membrane phospholipids extracellularly, thus resulting in reduced sperm viability and reduced impaired motility.³²

Studies proving that mobile phone radiation affects male fertility

Wdowiak et al. 2007 had reported that there was a decrease in the percentage of sperms and their motility which depending on the frequency of mobile phones usage.³³ Agarwal et al. 2008 found that the usage of cell phones resulted in a decrease in sperm count, motility, viability, and normal morphology and these changes in sperm cell parameters depends on the daily exposure to cell phones and thus independent of the initial semen quality.¹¹ He additionally found that RF electromagnetic waves emitted from cell phones showed reduced sperm motility and viability, increased ROS level, minimized TAC of semen (ROS-TAC score).²¹ Gutsch et al. 2011 found that mobile phone usage by the male was related to increased abnormal sperm morphology and increased serum testosterone and decreased gonadotrophin levels with no changes in FSH, and prolactin.³⁴ Rago et al. 2013 found that the utilization of mobile phone for more than 4 hours daily was associated with increased sperm cell DNA fragmentation.¹³ Yildirim et al. 2015 found that exposure to RF-electromagnetic radiation of mobile phone and wireless internet was related to decreased total motile sperm count, increasingly motile sperm.³⁵ Zhang et al. 2016 found that cell phone use might negatively have an effect on sperm quality in men by decreasing the semen volume, sperm count thus impairing male fertility.³⁶

Studies disproving that mobile phone radiation affects male fertility

In a study conducted by El-Healy et al. on 262 males, they had found that each patient's semen quality parameters did not show any difference among the mobile phone users depending on their daily use in minutes. However, the difference isn't significant and their study showed that those who use mobile phone for quite 60 minutes daily have lower semen volume, vitality and morphological index compared to those who used a mobile phone for less than 60 minutes per day.³⁷ Gutschel et al. stated that the use of cell phones has no deleterious effect on total sperm count.³⁴ In a cross-sectional study conducted by Rago et al. in 63 healthy and fertile men who visited the andrology centre, showed that none of the standard sperm parameters was altered in the semen analysis report as per the daily mobile phone usage in hours.¹³ Feijo et al. found that sperm parameters weren't considerably different in nonusers and users with increased mobile phone use and this study results are in line with the above authors.³⁸

Effects of the mobile phone carrying on pockets

The effects of RF-EMR on the quality of the sperm parameters depending on the way of carrying mobile phones, on a sample of 52 men aged 18–35 years showed that men who carried a mobile phone in their hip pockets or on their belts had a lower sperm concentration than men who do not carry a phone or who carried it elsewhere.²⁹ Also, in a hospital-based study conducted by El-Healy et al. they found that men who carried their mobile phone in their hip pockets had lower sperm motility proportion compared to male keeping mobile phones in a waist pouch, shirt pocket or hands, however, the difference was statistically insignificant. These results go with the study result of Agarwal et al., who postulated that keeping the mobile phone in a hip pocket in speak mode may negatively have an effect on sperm and thus impair male fertility.²¹

Effect of RF-EMF on sperm fertilization potential

According to Falzone et al., a reduction in sperm head area and its acrosomal percentage was reported among exposed sperm when compared to unexposed controls sperm.³⁹ Adding on to that the mean of zona-bound sperm of the test hemizona and controls was significant respectively. Researchers further stated that though radiofrequency electromagnetic fields exposure failed to adversely affect the acrosomal reaction; it also had a remarkable effect on sperm morphology. Also, a drastic decrease in sperms binding to the hemizona was traced out. These results may indicate a major change of RF-EMF on sperm fertilization potential.³⁹

Potential confounders in correlation mobile phone effects on male infertility

Various potential confounders, includes age factor, period of abstinence, tobacco and alcohol consumption, BMI, and beverages /fried food consumption, are thought to be valuable contributors to changes in semen quality in previous studies.^{40,41} In all the previous studies and the study was done by Zhang et al. age and lifestyle showed a strong correlation with semen quality; so, they ought to be adjusted to study the effect of other factors on semen quality.³⁶ They conjointly analyzed the potential effects of the multiple sexual partners and use of condoms on semen quality, each of that was prompt to incline the sexually transmitted infections, thus inflicting changes in seminal parameters.⁴² However, they failed to notice the valid adverse relationship between them. Negative associations remained still after the adjustment of all the above confounders. Together, these studies indicate that certain aspects of mobile phone use might negatively have an effect on semen volume, sperm concentration and sperm count.³⁶

Oxidative stress & DNA-damaged of spermatozoa due to RF-EMW

The development of oxidative stress or disturbance in free radical metabolism by mobile phone radiation has been shown in very few animal studies. Chronic exposure to RF-EMW can decrease the activity of catalase enzyme, superoxide dismutase (SOD), an antioxidant, and so decrease total inhibitor capability, however, experimental studies designed to estimate the malonaldehyde level and SOD activity show conflicting results.^{43,44} Friedman et al. showed that RF-EMW stimulates cell membrane NADH oxidase enzyme in mammalian cells and cause the production of ROS.⁴⁵ This could be attributed to a rise in the activity of spermatozoal NADH oxidase enzyme after RF-EMW exposure. Aitken et al. had shown that human spermatozoa possess a multiple cell membrane oxidoreduction system that shares similarities with transmembrane NADH oxidase enzyme.⁴⁶ Activation of cell membrane NADH oxidase enzyme might cause the production of ROS. This will be detected by luminol-based luminescence since luminol measures both intra and extracellular ROS.⁴⁷ In most of the studies, the pathology has been defined by loss of sperm motility and viability moreover because of the induction of ROS generation and DNA injury. The potential mechanisms were given thoughts through which RF-EMR might elicit various effects on spermatozoa, for which a sensitive model system was used. A mechanistic model during which RF-EMR exposure leads to defective mitochondrial function related to elevated levels of ROS production and results in anti-oxidative stress that may add on to the varying phenotypes determined in response to RF-EMR exposure was proposed. This model can offer new impetus to the researcher and stimulate research that allows confident

assessment of the reproductive organ involved hazards due to mobile phone usage.⁴⁸

CONCLUSION

Mobile phone radiations and RF-EMF has a deleterious effect on various organs of the human body. The thermal and non-thermal effects of electromagnetic waves on reproductive functions remain an inconclusive issue. The radiations damaging the Leydig cells, seminiferous tubules and thus causing semen parameters alterations have to be kept in mind. The sperm quality deteriorates day by day in the male population due to mobile phone radiations. This area had to be thrown light and enormous research has to be done to change the idealistic view of the researchers. Awareness has to be created among adolescents to safeguard themselves from mobile phone radiations.

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