Male Infertility and Radiofrequency Electromagnetic Wave Exposure

(Free Paper)

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Abstract

Purpose: Radio-frequency electromagnetic wave (RF-EMW) exposure has been postulated as one of many detrimental factors that affect sperm quality. This paper address is intended to discuss male infertility related to RF-EMW exposure.

Epidemiology: infertility affects 10-20% of all couples wanting children worldwide.

Biological evidence: Man-made RF-EMW radiation from devices used frequently in modern daily life such as mobile phone and portable computer has been proven to affect human body. Recent in-vitro studies suggest that RF-EMW exposure leads to reduced sperm motility, oxidative stress in human semen and DNA damage of human spermatozoa. The motility of normal spermatozoa may have decreased by disruption of protein-kinase C activity due to the RF-EMW exposure.

Implication: Authorities have yet to conclude specific regulation regarding RF-EMW radiation and its effects to male reproduction health. With the rise of Assisted Reproduction Technology (ART) that seems to solve so many cases of infertility, the actual causes of increasing infertility prevalence are yet to be identified. Intra-cytoplasmic sperm injection (ICSI), one of ART procedure, may bring couples to have offspring, but it also may by-pass the natural selection of sperm cells, and passes molecular and genetic damage.

Actions: Sophisticated methods to manage male infertility can be combined with simple, inexpensive such as reducing oxidative stress to reproductive system. Avoidance of intense RF-EMW exposure may benefits male reproduction and overall health. Moderate usage of antioxidant agents may also be beneficial maintain reproductive and overall of body health, as well as lifestyle modifications that has long been proven to reduce oxidative stress.

Conclusion: over-exposure of RF-EMW may serve as modifiable contributing factor to male infertility.

Keyword: electromagnetic wave, male infertility, oxidative stress, sperm quality, ART
Male Infertility: Epidemiological Evidence

It is generally accepted that one in seven couples who plan to have children will have problem to conceive. Of all couples that are sexually active and without any means of contraception, 92% of them can have pregnancy after two years, while the rest are said to have fertility problem. The exact epidemiological data of infertility in Indonesia is not yet available, but supposedly does not range very far from the worldwide data. Population of Indonesia in 2010 is reaching more than 237 millions, and 66.5% of them are 15 to 64 years old. Infertility may not be the biggest health problem in the country, but it is still a major issue.

Male infertility is as common as female infertility and as with infertility from both partners which all are about 30% (the rest 10% happens with no abnormalities). Male infertility affects one in 20 males of the population. Despite large number, causes of male infertility are yet to be determined. Advances in Assisted Reproductive Technology (ART) may overcome infertility, but the cause of male infertility itself is yet to be identified.

One of the many factors affecting male infertility and sperm quality is electromagnetic wave exposure. With the rise of information technology, usage of devices that transmit electromagnetic wave, such as mobile phone, has become worldwide. Studies have found that electromagnetic radiation from mobile phone has been proven in vitro to reduce sperm motility, induce oxidative stress in human semen and DNA damage of human spermatozoa.

Other source of electromagnetic wave radiation that closely related with modern lifestyle is Wi-Fi signal used in portable computers to connect to internet. Although study in such topic is very limited, it has shown that not only the heat exposure from the laptop that is detrimental, but the electromagnetic wave from Wi-Fi connection in actively used laptop placed near the scrotal area decrease progressive movement of sperm cells and increase the risk of DNA fragmentation.
These findings show that one probable cause of male infertility is prolonged exposure to radiofrequency electromagnetic radiation (RF-EMR). Unfortunately, in our modern life, source of man-made electromagnetic radiation is very common; mobile phone and internet connection through portable computer with Wi-Fi connectivity have become integral part of our daily life.

**Biological Plausibility**

The amount of radiofrequency electromagnetic radiation to human tissue can be measured in SAR, Specific Absorption Rate, and the unit is Watt per kilogram. SAR actually measures the rate of energy absorption of tissue, not specific to energy transmitted in electromagnetic wave only, but it is commonly used to express the energy produced by mobile communication devices.

Evidences show that transmitted energy from such devices has potential harm to human body. The fact that radiofrequency electromagnetic radiation may harm to several tissue may still be debated but more studies have shown the negative impact.

In vivo approach to study the effect of radiofrequency electromagnetic radiation on male reproduction system is unethical. Other than that, identifying control group in in-vivo studies will require people that are not exposed to radiofrequency electromagnetic radiation, which is almost impossible. In vitro approach allows observation of the cellular mechanisms that are involved in the pathophysiological processes.

Agarwal *et al* and Desai *et al* propose that although damage from radiofrequency electromagnetic radiation to the head may be limited by regulating the head SAR number of available mobile phone in the market, it does not prevent people from placing their mobile phone near scrotal area, such as pant pocket or waist belt.\(^8,10\) Such placement poses even higher negative effect when phone user activates wireless feature of their mobile phone, such as Wi-Fi connection or Bluetooth earpiece.
There are several mechanisms that explain the detrimental effect of radiofrequency electromagnetic radiation that similar with the radiation from mobile phones to male reproduction system. De Iuliis et al suggest that radiofrequency electromagnetic radiation induce reactive oxygen species production, decrease motility and vitality, and ultimately stimulate DNA damage of human spermatozoa. They used both high SAR value (27.5 W/kg) and low SAR value similar to regular mobile phone radiation (0.5-1.5 W/kg). The result is that exposure to radiofrequency electromagnetic radiation gives negative effect to semen parameters in both setting and the effect seems to be dose-dependent.

Desai et al propose that oxidative stress from such radiation induce NADH oxidase enzyme stimulation which may play key role in the various adverse effects observed in in-vitro studies, such as gene expression, release of calcium ion from intracellular storage sites, cell growth, and apoptosis. They also suggest that spermatozoa may have decrease motility by disruption of protein kinase C activity. Therefore, they summarize that detrimental effects of radiofrequency electromagnetic radiation to male reproduction system are due to oxidative stress and changes of protein-kinase C activity.

Other than mobile phone radiation, portable computer/ laptop with active Wi-Fi connectivity is also one source of radiofrequency electromagnetic radiation. Studies in this area are much less than with mobile phones, but the same level of importance arises since both devices emit the same kind of radiation. Avendano et al measured radiofrequency field radiation in in-vitro setting using actively downloading and uploading laptop with Wi-Fi connection. The laptop was set at 3 cm from Petri dish containing prepared semen sample at 25°C to prevent thermal effect to occur, at the duration of four hours. They believe that setting mimic actual condition when laptop is used on the thighs. The result is that DNA damage of the sperm cells occurs from non-thermal factor.

Avendano et al and Desai et al perform their studies in in-vitro setting that the cell can only survive within limited time. It is important to bear in mind that in-vivo situation,
sperm cells spend about a week in the seminiferous tubule in the testes before they can reach cauda epydidimis and those cells are vulnerable to the radiation during the whole time.\textsuperscript{11}

**Clinical and Public Health Implication**

Many relevant studies have established that oxidative stress correlates negatively with semen parameter. The clinical implication of those findings directly related to the community health, especially male reproductive health. Although WHO has already launched the 2010 research agenda for radiofrequency fields and state the importance of radiofrequency effect on neurological health,\textsuperscript{12} they are yet to state the importance on reproductive health. Having the worldwide prevalence of 30\% of total infertility cases,\textsuperscript{4} male infertility needs more concern from the public and authority as well.

Regulation of SAR in the United States oblige that all mobile phone must have SAR value less than 1.6 W/kg. Although mobile phone company shows measurement of their products, there are some situation that this information in not sufficient, such as different usage of each mobile phone, different placement while using the device, different feature that use radiofrequency, and more else. Federal Communications Commission themselves stated in their website that SAR number needed to interpreted with caution,\textsuperscript{13} but it is yet to clarify specifically the meaning of SAR number regarding male reproduction health.

The importance of healthy male reproductive capability is not the privilege of one generation only. Assisted reproduction techniques may by-pass the natural selection of sperm cells. The sperm with damaged DNA may have normal appearance to standard reference and when used to fertilize, may pass that damage to the offspring.\textsuperscript{14} As De Iuliis \textit{et al} concluded, environmental factor such as radiofrequency electromagnetic radiation affects not only males’ fertility, but also the health and well being of their offspring.
Promotive, Preventive and Curative Actions

More rigorous attempt needs to be done in finding and solving the genetic and environmental factors that lead to male infertility problems like motility, morphology and DNA damage of sperm cells. Otherwise, management of infertility will not be causative treatment, but only serve as symptomatic approach of the current and future problems.

Assisted Reproductive Technology (ART) as the latest breakthrough in the world of human reproduction has undoubtedly helped millions of couple all around the globe. While current inventions such as intracytoplasmic sperm injection (ICSI) overcome infertility problem like never before, sperm cell with damaged DNA can have normal motility and morphology and can still be used in standard ICSI procedure and in the end, produce failed embryo development.\textsuperscript{14,15}

Oxidative stress in reproductive system as one pathophysiology of male infertility has shed light to preventive fertility strategies. Avoidance of environmental factors such as prolonged exposure of radiofrequency electromagnetic radiation from devices that are frequently used may benefit the overall male reproductive health.\textsuperscript{6-10} Simple precautionary actions like proper placement of communication devices, such as mobile phones and laptops, while used for wireless communication or left in idle state, may benefit the user in term of reproductive health.

Although the role of antioxidant role is paramount in alleviating oxidative stress, the approach of using antioxidant agents as a standard procedure in management of infertility is still debated.\textsuperscript{16} Still, usage of moderate antioxidant agents is not harmful and potentially bring positive effect to maintain overall state of body health.

Together with Assisted Reproductive Technology, inexpensive yet equally effective lifestyle modifications, such as smoking and caffeine cessation, avoidance of environmental toxic in workplace bring better outcome in infertility management.\textsuperscript{14} The choice of dietary
pattern that contains high level of fibers and antioxidant improve semen quality and ultimately, male fertility. 17,18

**Conclusion**

Probable causes and causative treatment of male infertility are not yet pinpointed and over-exposure of RF-EMW may serve as modifiable contributing factor to male infertility.
References


