Short report of the Indian studies

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Studies on reproduction

i. **Shahin et. al., Free Radic Res. 2014; 48(5):511-25.**

The study reported that MW irradiation induced a significant decrease in sperm count and sperm viability along with the decrease in seminiferous tubule diameter and degeneration of seminiferous tubules. Reduction in testicular 3β HSD activity and plasma testosterone levels was also noted in the exposed group of mice. Increased expression of testicular i-NOS was observed in the MW-irradiated group of mice. Further, these adverse reproductive effects suggest that chronic exposure to nonionizing MW radiation may lead to infertility via free radical species-mediated pathway.

ii. **Meena et. al., Electromagn Biol Med. 2014; 33(2):81-91.**

The present study reported that melatonin prevent oxidative damage biochemically by significant increase ($p < 0.001$) in the levels of testicular LDH-X, decreased ($p < 0.001$) levels of MDA and ROS in testis ($p < 0.01$). Meanwhile, it reversed the effects of MWs on XO, protein carbonyl content, sperm count, testosterone level and DNA fragmentation in testicular cells. These results concluded that the melatonin has strong antioxidative potential against MW induced oxidative stress mediated DNA damage in testicular cells.

iii. **Veerachari and Vasan, Int J Infertility Fetal Med 2012;3(1):15-21.**

The Human semen samples exposed to EMR showed a significant decrease in sperm motility and viability, increase in reactive oxygen species (ROS) and DNA fragmentation index (DFI) compared to unexposed group. We concluded that mobile phones emit electromagnetic waves which lead to oxidative stress in human semen and also cause changes in DNA fragmentation. We extrapolate these findings to speculate that these radiations may negatively affect spermatozoa and impair male fertility.

iv. **Kesari et. al., Appl Biochem Biotechnology (2012) 166:379-388.**

The study aims to investigate the effect of 2.45 GHz microwave radiation on wistar rates. A significant decrease ($P<0.05$) was recorded in the level of pineal melatonin of exposed group as compared with sham exposed. A significant increase ($P<0.05$) in creatine kinase, caspase 3 and calcium ion concentration was observed in whole brain of exposed group of animals as compared to sham exposed. The alteration in expression of these biomarkers clearly indicates possible health implication of such exposures.

v. **Kumar et. al., Clinics (2011)66:1237-1245.**

Another study in male Wistar rats concluded that Electromagnetic fields are recognized as hazards that affect testicular function by generating reactive oxygen species ad reduce the bio-availability of androgen to maturing spermatozoa. Thus, microwave exposure adversely affects male fertility.

vi. **Kesari et. al.**, **Indian Journal of Experimental Biology (2010) 47:987-992.**

The results indicated significant reduction in testicular size, weight and in sperm counts. The data also indicated that the chronic exposure to Radio Frequency Radiation (RFR) imitated from cell phone causes a significant decrease in protein kinase C and total sperm count along with increase apoptosis in male rat.

Studies on audiology

vii. **Panda et. al., Otolaryngol Head Neck Surg. (2011); 144(4):581-5.**

This study was undertaken to assess and compare potential changes in hearing function at the level of the inner ear and central auditory pathway due to chronic exposure to electromagnetic waves from both global system for mobile communications (GSM) and code division multiple access (CDMA) mobile phone usage. One hundred twenty-five subjects who were long-term mobile phone users (more than 1 year; 63 GSM and 62 CDMA) and 58 controls who had never used mobile phones underwent audiological investigations including pure tone audiometry (250-12 kHz), tympanometry, distortion product otoacoustic emissions (DPOAE), auditory brain responses (ABR), and middle latency responses (MLRs). The changes in various parameters were studied in mobile-using and non-mobile-using ears of both GSM and CDMA subjects and corresponding ears of the controls to ascertain the effects of electromagnetic exposure. GSM and CDMA users were found to be at a significantly higher risk of having DPOAE absent as compared with controls ($P < .05$). They were found to have higher speech frequency thresholds and lower MLR wave and Na and Pa amplitudes. More than 3 years of mobile phone usage emerged as a risk factor ($P < .05$). The damage done was bilateral, with the quantum of damage being the same for both GSM and CDMA. Long-term and intensive GSM and CDMA mobile phone use may cause damage to cochlea as well as the auditory cortex.

viii. **Sahoo and Sebastian. Indian Journal of Otology (2011): 17 (3): 97-100.**

Mobile phone usage is widespread and concerns have been raised on the safety of its long-term usage. The electromagnetic fields emitted from mobile can penetrate skull and deposit energy 4-6 cm into the brain resulting in heating of the tissue. In this study, we explore a possible relationship between prolonged mobile phone usage and sensorineural deafness. The study was conducted in a medical college situated in rural India. A total of 100 persons between the age group of 20-45 years using mobile phone for at least 5 years are selected and screened for sensorineural deafness. Use of cellular phones was assessed by a questionnaire. Mean number of daily calls and minutes were asked for to calculate the cumulative use in hours for all years. The most frequently used ear during cellular phone calls was noted, or whether both ears were used equally. Otoscopic examinations were performed by an otolaryngologist before testing in order to rule out any external or middle ear pathology that could affect audiometric measurements. The hearing levels of subjects were tested using pure tone audiometry. One hundred subjects who are habitual mobile

phone users were screened by pure tone audiometry. It is found that the prevalence of sensorineural deafness was 3% and there is a linear relationship between the duration of mobile phone use and the degree of the severity of deafness. The prevalence of sensorineural deafness in our study in habitual mobile users is 3%. It is not clearly known whether mobile phone use is the direct cause of deafness in these subjects but the absence of other causes might point towards its etiological role.

ix. Panda et. al., **J Otolaryngol Head neck Surg (2010) 39:5-11.**

A retrospective, cross sectional, randomized, case control study was carried out in a tertiary care hospital. One hundred twelve subjects who were long term mobile phone users (more than 1 year) and 50 controls who had never used a mobile phone underwent a battery of audiologic investigations including pure-tone audiometry (both speech and high frequency), tympanometry, distortion product otoacoustic emissions, auditory brain responses, and middle latency responses. Changes in the various parameters were studied in the mobile phone and non-mobile phone using ears of subjects and corresponding ears of the controls to ascertain the effects of electromagnetic exposure. There was no significant difference between users and controls for any of the audilogic parameters. However, trends for audiologic abnormalities were seen within the users. High frequency loss and absent distortion product otoacoustic emissions were observed with an increase in the duration of mobile phone use, excessive use of mobile phones, and age more than 30 years. Additionally, users with some complaints during mobile phone use demonstrated absent distortion product otoacoustic emissions and abnormalities in auditory brain stem response. This study reported long term and intensive mobile phone use may cause inner ear damage.