



The Debate of Mobile Radiation on Maxillofacial Structures: A Myth or Reality?

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Abstract

Concerns have been raised because of rise in mobile phone usage. Even small risks for developing chronic diseases such as cancer from mobile phone use is in consideration because of high exposure to high-frequency electromagnetic fields (EMFs) as handheld mobile phones emit nonionizing electromagnetic radiations and generate heat during use which can be absorbed by the adjacent tissues. The electromagnetic rays emitted from cell phone usually between 301MHz and 950 MHz depending upon the type of device, frequency and duration of use. Long duration of mobile use can lead to increase in temperature of the exposed areas and surrounding tissues which could have ill effects on human body especially the contact areas, oral & perioral tissues. This review highlights the possible association between cell phone radiations and its effects on the oral tissues.

Introduction

The advancements in technology have refined telecommunication. Mobile phones and their innovations in order to trend the latest designs are of concern in this sector. In the recent decade, a rise has been seen in smart phone usage due to its multipurpose action i.e., portable connectivity, multifunctional services and convenience of use of mobile phones have caused an exponential rise in the number of users, number of calls per day, length of call, and the amount of time people use mobile phones. This rapid increase in cell phone usage has raised concerns about potential risks associated with exposure to radiation produced by mobiles. Mobile phones are known to generate heat and emit radio frequency radiation in the form of nonionizing electromagnetic radiations in the range of 800-2,200 MHz, similar to many home appliances.[1,2]

The long duration and proximity of mobile phones to human body during use has given rise to concerns of possible adverse effects resulting from absorption of these emissions by the tissues adjacent to the area of mobile phone handset use. The parotid glands are the largest salivary glands in the human body which are located in front of the ear, beneath the skin of the face, most of times in contact with handheld mobile phones when in use.

This makes parotid glands vulnerable to changes, if any, resulting from mobile phone heat and radiation due to prolonged conversations; the mobile phone gets heated up and increases the temperature of the surrounding tissues in contact and due to non-thermal effects due to cumulative effects from both phones and base stations. Also, standing near cell phone towers or smart phones could have non-thermal effect on tissues.[3] In 2012, the International Agency for Research on Cancer (IARC) concluded that radiofrequency electromagnetic fields as possibly carcinogenic to humans and classify it as Group 2B agent (Group 2B: The agent is possibly carcinogenic to humans).[4] Even when smart phones are not in use, they emit radiation. Mobile phones irrespective of its position, generates radiation that are harmful to the body. It is assumed that, during longer telephonic conversations; smart phone generates heat that spreads to the surrounding tissues in contact. Head and neck region mainly absorbs the heat generated by the smart phone. Exposure to radiation for more than 2 hours is proven to have deleterious effect.[5] It is proven that electromagnetic radiation from cell phones causes DNA damage.[6] A very contradicting literature exists regarding the potential of mobile phone emissions (thermal and radiation effects) to cause notable physiologic, structural, functional, or even carcinogenic changes in the human body. Studies conducted previously have both suggested and denied correlation between adverse health effects, such as headaches, migraines, brain tumors, auditory canal pathologies, and physiologic changes in the salivary glands, and mobile phone use. This contradiction can be attributed to inaccurate reporting by the participants about their mobile phone use habits or by participation of the next of kin of subjects who are unaware of actual use habits, and participation of individuals after diagnosis of a disorder, because these subjects can have negative responses to questionnaires, implying an entirely different etiology than the actual cause.

Discussion

More than 750 million people around the globe use smart phones. The signal frequency differs in every country. Mobile radiation causes both thermal and non-thermal changes in human cells. Radiation from smart phone ranges between 0.2 and 1.5 W/kg. Maximum dose of 2 W/kg radiations is the limit to human head. When radiation exceeds the limit, it results in various injurious effects. The International Commission on Non Ionizing Radiation Protection has standardized the frequencies at 300 GHz as limit.[7]

According to Friedman et al 2007, the radio extracellular superoxide phones induce plasma membrane to form NADH oxidase which in turn produces extracellular superoxide that leads to oxidative stress and subsequent carcinogenesis.[8] Also, Hardell et al in their study in 2007 concluded that smart phone users have a greater liability of developing gliomas, neuromas and many other types of carcinomas. Tumors are more likely to appear on the frequently used side of the head. Age is found to be a significant factor in the occurrence of complications from smart phones.[9]

The frequency of cellular phone used determines the amount of exposure to radiations. The mechanism of radiant energy absorption into the human body dependent upon: (i) the wavelength of the signal and size of the body part; (ii) the radiofrequency signal couples with the tissues; and (iii) resonant absorption of the energy[10] The ill effects of using smart phone includes light headedness, migraine, burning sensation in eye, dizziness, sleep deprivation, loss of mental orientation, hallucination, hearing impairment, visual disturbance, cancer etc. Few studies have quoted adverse effects of cell phone radiation on behavior, sleep, electroencephalograph and sperm count. However, these symptoms could occur even during stress without getting exposed to cell phone radiation.[11]

S. Gopalakrishnan et al stated that Kids have higher tissue conductivity to E-Rays compared to adults' brain and absorbs radiation deeper in the brain.[12] Studies showed that absorption of microwave radiation is 10 times higher in children than in adults due to the fact that children skull are smaller and thinner compared to adults.[13] The reason behind this could be the lesser tissue repair due to ageing. Several data supports this concept.[14] Due to the electrical activity of the brain, the nervous system may be the main target for the study of radiofrequency radiation effects on `biological substrates. The effects on nervous systems includes SH-SY5Y neuroblastoma and SN56 cholinergic cell lines and cortical neurons.[15] Loss of one-electron in the outermost shell results in reduction of oxygen, such as singlet oxygen, superoxides, peroxides, hydroxyl radical and hypochlorous acid form the reactive oxygen species (ROS). ROS causes oxidative damage of DNA, proteins, lipids and small intracellular molecules, which are associated with contributing factors for alteration in gene expression, intracellular calcium release, cell growth, proliferation, differentiation and apoptosis. RF waves effect on glutamate toxicity results in neurodegenerative diseases including stroke, epilepsy.[16]

Oxidative stress occurs as a result of disequilibrium between ROS and antioxidants. Animal models showed that oxidative stress caused by radio waves can be controlled by increased levels of antioxidants like melatonin, phenyl ester, vitamin C and E.[17]

Biochemical study of saliva sample after using mobile phone for 15-30 min showed a significant increase in the superoxide dismutase enzyme in the initial phase followed by a drop.[18] Cell phone increases the temperature of the surrounding tissues and cause facial nerve dysfunction. The salivary flow rate is altered with increased cytokine expression profile in heavy cell phone users. Cell phones do not cause tumour of the salivary gland directly, but few studies had found adverse effects on orofacial structures.[19] Bhargava et al 2012, noted a significant enlargement in the parotid gland volume on the frequently exposed side.[20] Few studies have proven that long term exposure to cell phone radiation causes oxidative stress, which is one of the aggravating factors for periodontitis. Increased radiation could have an impact on periodontal tissues. This was proven by Syed Sirajuddin et al 2018.[21] Kaya FA et al 2008 studied the histological effects of E-Rays on the gingiva of rabbit. There was abundance of inflammatory cells [PMN's]. Exposure to radiations for two hour/day for a period of 10 months produced gingival bleeding in rat model.[22] Mortazavi SM et al.[23] found a significant effect on amalgam restorations due to use of mobile phones. They found a significant release of mercury from dental amalgam restorations due to radio waves emitted from mobile phones.

According to WHO, mobile phones have the potential to cause brain and auditory canal tumors, similar to conclusions offered by Hardell et al. (2007) that use of mobile phones for 10 years give a consistent pattern of increased risk for acoustic neuroma and glioma. But unlike the brain and auditory canal, the superior lobe of parotid glands are without natural protection of skull and are at a closer proximity to mobile phones when in use and therefore potentially at greater risk of adverse effects from cell phone use. Cardis et al. (2008)[24] reported that 97–99% of the total elec-tromagnetic energy deposited in the brain is absorbed at the side of the head the phone is held during calls. Epidemiologic evidence compiled in the past 10 years starts to indicate an increased risk, in particular for brain tumors (glioma, meningioma, acoustic neuroma), from mobile phone use. Considering biases that may have been operating in most studies, the risk estimates are rather too low, although recall bias could have increased risk estimates. The net result, when considering the different errors and their impact, is still rather an elevated risk.

The magnitude of the brain tumor risk is moderate, but it has to be borne in mind that estimates are still from short durations of exposure. From the perspective of public health, an increase of brain tumor incidence of $\geq 50\%$ poses substantial problems for neurosurgical care, but the individual perspective is less dramatic: in industrial countries, the lifetime brain tumor risk is 4–8 per 1,000. If mobile phone use should increase these figures to 6–12 per 1,000, the individual risk is still low. At present, evidence for a causal relationship between mobile phone use and brain tumors relies predominantly on epidemiology, in particular on the large studies of Hardell and colleagues, but there are no valid counter arguments and no strong evidence decreasing confidence in a causal relationship. Weak evidence in favor of a causal relationship is provided by some animal and in vitro studies, but overall, genotoxicity assays, both in vivo and in vitro, are inconclusive to date.[25]

Conclusion

In general, we know that major purpose of cell phone is for communication and the use of hands-free mode and headphones could reduce the high temperature produced by mobile phone on the surrounding tissues. The lesser use of mobile phone can diminish the noxious effects of mobile radiations. Cell phone emitted radiations had their adverse effect on salivary glands and facial nerves. Studies showed that cell phone emitted radiations had effects on oral mucosal cells and causes changes in salivary flow rate. It was still unclear that cell phone radiations cause tumours of the salivary glands. At present, evidence for the relationship between mobile phone use and brain tumors relies predominantly on epidemiology, in particular on the large studies of Hardell and colleagues, but there are no valid counter arguments and no strong evidence decreasing confidence in this causal relationship. Detailed researches on cell phone radiation are required to prove their effects on oral tissues.

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