The Side Effects of Electromagnetic Waves on the Human Brain

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ABSTRACT:

As technology progress, the development of telecommunication industries, the construction of new electrical devices, and their application in human life have affected human health in various ways. Some of the devices that emit electromagnetic waves and are exposed to humans include Cell Phones, TV, Computers, cellular networks, and base transceiver station towers. The brain is one of the parts of the human body that is constantly affected by these waves. The paper aims to study the effects of cell phone electromagnetic waves on the human brain.

KEYWORDS: Cell Phone, Electromagnetic Waves, Human Body, Human Brain.

1. INTRODUCTION

With the increasing use of electrical devices, the human body is affected by electromagnetic fields (EMF) [1, 2]; therefore, numerous research is carried out on the impact of these waves on biological systems following scientific and technological advances and the construction of new devices, and the presence of humans exposed to these waves [3-5]. However, electromagnetic fields are known as a form of noise-free pollution [6]; and electromagnetic radiation (EMR) is widely applied in modern technology and communication [7]. Particular devices that emit electromagnetic waves and are exposed to humans include cell phones, televisions, computers, microwaves, cellular networks, and base transceiver station (BTS) towers [8].

The cells of the human body, however, communicate with each other in the range of 10 to 1000 Hz, and most mobile phones communicate in the range of 270 to 1800 Hz; as a result, the range of mobile electromagnetic waves overlaps with the human intercellular communication system and, therefore, causes disruption in the body. These radiations are divided by parameters such as signal changes, radiation intensity, and the amount of radiation, the highest amount of radiation is related to the mobile phone [9]. Germany, for instance, is one of the countries that is exposed to high-frequency GSM telephone towers in residential regions [10]. Mobile phones hold a frequency of 900 - 1800 MHz with a pulse of 218 Hz. This frequency range is applied in most European and Asian countries, including Iran [11]. However, cell phone waves are safe because they are non-ionized [12, 13]. Excessive application of the communication devices is such that many individuals are exposed to radiation, from an early age to the end of life [14].

2. PREPARING PAPER NEGATIVE EFFECTS OF ELECTROMAGNETIC WAVES ON THE HUMAN

Electromagnetic waves carry energy, and waves absorbed by the human body are likely to increase the temperature of body tissues [15, 16]. Moreover, electromagnetic fields increase the concentration of free radicals in the chemical environment; and many medical studies demonstrate the presence of uncontrollable free radicals that directly cause difficulties [17, 18]. Studies show that long-term exposure to the waves may lead to various diseases such as tumors, cancer, infertility, cell and DNA injuries, cardiac arrhythmia, and brain, eyes, and bone damage [19-24].

3. LITERATURE REVIEW

In recent years, however, several works study the effect of electromagnetic waves on different parts of the human body. Gabrie et al. [25, 26], tested several experiments on the effect of dielectric properties on various tissues of the body in the frequency range of 10 - 20 Hz. In another study, Bauman et al. [27] investigated the effect of changing frequency and temperature on the electrical conductivity of the human brain. Schmid et al. [28] performed experiments on the dielectric properties of the human brain. Furthermore, Yioultsis [29] study the effects of electromagnetic radiation and temperature analysis on the body caused by different types of antennas. The results of Pecyna [30] research, indicate that cardiorespiratory indices are affected by exposure to magnetic fields. Moreover, by applying the finite difference time domain (FDTD) in a 2D environment, Ismail and Zara [31], modeled the emission of mobile phone-induced electromagnetic waves in the human head. Faruque et al. [32], utilizing the FDTD, compared the effect of electromagnetic waves on some types of antennas, including Helical, Monopole, PIFA, and Patch at different frequencies. In four different modes on the human head, Tomovski [33] studied the effects of electromagnetic fields in 2D and FDTD.

Generally, numerical methods are applied to determine the distribution of fields in and around the human body in the presence of electromagnetic sources; which are studied by several papers [34]. To study the effects of cell phone waves, however, the brain is subjected to more studies than other organs (Fig. 1). The effects of brain exposure on cell phone waves depend on the type of phone and its antenna; however, the effects are much greater in the temporal lobes, the insular region, the upper surface of the skull, the scalp, and the glands of the ear [17]. Moreover, the part of the human head where the mobile phone is held is more affected than other areas, and this effect is more obvious in children since it increases their cerebrospinal fluid content and decreases brain volume because of the thinness of the scalp.

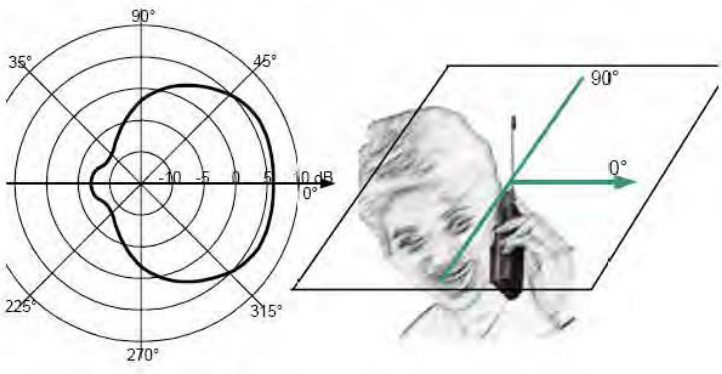

Fig. 1. Electromagnetic Radiation near a Human Head [8]

Richardson et al. [18], show that two hours of 915 MHz mobile phone irradiation with non-calorific specific absorption rate (SAR) of 0.12, 12, and 120 mW/k increases the amount of albumin in neurons after 14 days of irradiation and after 28 days of irradiation causes neuronal damage and 50 days after irradiation Increases the permeability of the blood-brain barrier. Nittby et al. [35], indicate that the effect of cell phone waves on the human brain is likely to be because of mechanisms such as changes in perception of tasks, changes in the level of neurotransmitters (reduction of cholinergic activity), changes in the cerebellum's genes, cerebral cortex, hippocampus, and electrical activity. In a study examining the effect of cell phone waves on individuals who used a cell phone while driving for two weeks, Schlehofera et al. [36] found that using a mobile phone may reduce concentration and speed of operation and increases the number of driving errors. Furthermore, disorders, sleep disturbances, and biological reactions caused by stress, depression, and anger of individuals in public are similarly introduced as the effects of mobile phones.

Aggarwal & Gupta [37], indicate that aggression is one of the major side effects of cell phone use. However, their results show that cell phone, particularly texting, increases the risk of aggression and anger. Mobile phone users' brain activity changes dramatically if they are exposed to cell phone waves for about 30 minutes before they fall asleep. However, changes in brain activity cause individuals to have disturbed sleep, which may lead to Alzheimer's disease. Subsequently, numerous papers dealt with the effect of the waves on the human brain.

Preece et al. [38], hold that seizures because of high electrical discharge are sudden and usually limited to a group of brain cells (neurons) and that different parts of the brain may be the region of such discharges. However, electromagnetic fields emitted from cell phones are likely to irritate the brain and cause difficulties for individuals with epilepsy or other brain disorders. Correspondingly, one of the affected sides of the long conversations is excessive stress, which ultimately leads to mental fatigue. Moreover, Ireland and Abbosh [39], studied the effect of mobile waves on the brain, using numerical modeling and problem-solving methods, assuming a bipolar antenna for mobile phones. Instead of applying the rigid and complex core model of the brain, Khodabakhshi & Cheldavi [40], considered a six-layer environment with a magnetic profile for each layer.

The literature, however, benefits from a complex and tedious analytical method to study the adverse effects of mobile waves on the brain. The effect is studied by applying numerical modeling and analytical problem-solving techniques and assuming a bipolar antenna for mobile.

Jafari et al. [20], simulated mobile radiation near the heads of adults and children. Applying high-frequency structure simulation (HFSS), they simulated the effect of waves on the brain. in their study, however, they considered a heterogeneous six-layer spherical environment with specific magnetic characteristics (Fig. 3) instead of the original brain model (Fig. 2). The results are studied for simulating the presence of a mobile phone on the skin and skull of an adult, as well as comparing the penetration of electromagnetic fields in the brains of adults and children. Subsequently, the effect of mobile waves on the brain is studied by applying a hybrid approach, namely, the Finite Element Method (FEM) [41-44], boundary integral (BI), and MATLAB. The results show that the penetration of electromagnetic fields in the brain of young children is more than adults; therefore, mobile phone use is far more harmful to children than to adults.

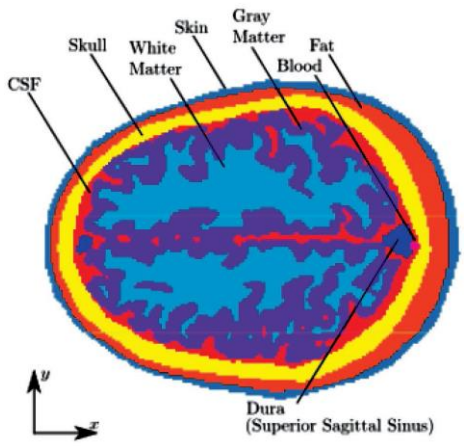

Fig. 2. Components of the human brain [39]

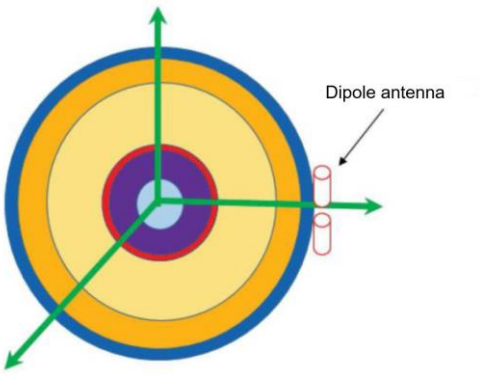

Fig. 3. Simplified model of six layers of the brain in the presence of a bipolar antenna (Cell phone) [20]

4. CONCLUSIONS

Despite the benefits they bring to users, advances in technology and communications hold particular difficulties. Electronic devices are sources of electromagnetic waves, such as computers, microwaves, cellular networks, and BTS towers. However, constant exposure to the waves of these devices may cause diseases in different parts of the human body. This paper, studies the negative effects of electromagnetic waves on the human brain.

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