Effect of electromagnetic field of mobile phones

Introduction

Mobile phones have become indispensable as communication tools in the present world. From 1990 to 2013, worldwide mobile phone subscriptions grew from 12. 4 million to over 6. 8 billion, penetrating more than 95% of the global population and reaching thebottom of the economic pyramidto cater to the lower socioeconomic groups as well (International Telecomunication union, Geneva). The Indian telecom industry has undergone market liberalization at a very rapid pace and grown since 1990. Today, India has become one of the fastest growing telecom markets in the world. India is the world’s second largest mobile phone user base with over 929. 37 million users in the year 2012 (Mittal Anuj 2013) (TRAI).

Widespread mobile phone ownership and usage has aroused public concern over possible harmful biological effects of their use. Electromagnetic frequencies of mobile phones emit radiations between the 800 MHz and 2000 MHz, which causes excitation and rotation of water molecules and some other organic molecules, hence causing thermal and non-thermal effects on humans (Frey AH, 1998). Effects of electromagnetic fields (EMF) transmitted by mobile phones over human health, is a matter of public and scientific concern. Burning sensation and sensation of warmth around the ear (Oftedal G 2000), headache (Frey AH, 1998), sleep disturbance (Borbely AA, 1999), changes in the cognitive functions and neural activity (Preece AW, 1999) (Hamblin DL, 2004), as well as changes such as decrease in the cerebral blood flow and alteration in functioning of blood brain barrier has been reported as the effects of mobile phones use. (Fritze K) (Haarala C, 2003). The potential carcinogenic effects of radiations emitted from mobile

phones is controversial (Repacholi MH, 1997) (Moulder JE, 1999). Therefore, any biological effect related to mobile phone use, should be considered as a high-priority health issue.

The hearing system is in the close proximity to the mobile phone so hearing system is potentially the most affected target for thermal and non-thermal effects. The external ear provides the route by which electro-magnetic frequencies from mobile phones reach the peripheral and central auditory system, which leads to relatively high energy deposition in the ear. The auditory system and particularly the cochlear outer hair cells (OHC) are known to be highly sensitive to a variety of exogenous and endogenous factors. Externally applied electrical and magnetic fields are known to produce some hearing sensation in the ear (Watanabe Y, 2000). Proximity of ear to electromagnetic source may lead to even larger damage and side effects such as hearing loss. One report, released from researchers at the Post Graduate Institute of Medical Education and Research in Chandigarh, India, revealed that people who talk on a cell phone for more than an hour a day were found to have sufferedlosses of high-frequency hearing(Panda NK, 2010).

However, little attention has been paid to the effects of electromagnetic field (EMF) of mobile phones on hearing. Till date, the interaction between electromagnetic fields (EMF) emitted by mobile phones and auditory function is not well established. Clear conclusions cannot be drawn from studies available, about the presence or absence of effects because of the limited sample sizes and short duration of studies.

Despite of all these evidence, only recently, some studies have analyzed the effects of mobile phones on the human auditory system. However, the results are not consistent and are variable among different study designs.

Only limited research data concerning interaction between EMF emitted by mobile phones and auditory function and possible impact on hearing, are available in the literature. The animal experiment, distortion product otoacoustic emissions (DPOAEs) did not show statistically significant changes on the outer hair cells functionality of adult as well as developing rats exposed to EMF at 900-1800 MHz frequencies for 1–2 h per day for 30 days(Parazzini M, 2002) (Kizilay A, 2003).

No appreciable change was seen in evoked otoacoustic emissions (OAEs) and none of the subjects reported a deterioration in hearing threshold level after 10 minutes exposure to the EMFs emitted by mobile phones in a recent human experiment to study the effects of the EMF of mobile phones on hearing status(Ozturan O, 2002). Other studies based on the brainstem evoked audiometry response (BERA) concluded that 30 minutes of mobile phone use has no adverse effect on the human auditory system(Arai N) (Gábor Stefanics, 2007). These small number of publications show that there is a big gap in the knowledge of potential biological effects of cellular phone use on hearing.

Mobile phone is based on the two way radio communication between a portable handset and closest base station. Cellular system divides the city into small cells, which vary from hundreds of metre in densely populated areas, to kilometres in the sparsely populated areas. Each cell has abase

stationthat consists of a tower and a small building containing the radio equipment. A cell phone is aduplexdevice, which means that there are two different frequencies, one for talking and another separate frequency for listening. Therefore, both persons can talk on the call at the same time. Mobile phones operate withincells, and they can switch cells as from one cell to another as we move around from one place to another. This gives cell phones this incredible range, because the call is transferred between the base stations (cell) without interruption.

The radio communications utilizes electromagnetic waves at frequency around 900 MHz to carry information via small change in the wave's frequency. A base station antenna typically radiates the radiations of about 60 Watts and a handset emits the radiations of 1-2 Watts. The antenna of a mobile phone emits radiations equally in all directions but a base station, unlike cell phone, produces a beam that is much more directional.

There are two common technologies used by mobile-phone networks for transmitting information:

TDMA [(Time Division Multiple Access) also known as GSM(Global System for Mobile communications)] does it by chopping the signals into sequential time frames. Each user of the channel takes turns to transmit and receive signals. In reality, only one person is using the channel at a given point of time. One of the important features of GSM system is theSubscriber Identity Module (SIM card). The SIM is a small, detachablesmart card, which contains the user's subscription information (i. e. validity and talktime) and phone book. This allows the user to retain his or her information while switching mobile

phone handsets. Alternatively, the user can also change service provider while retaining the handset, by changing the SIM card. GSM is currently the market leader in mobile phone industry (Michel Mouly, 1992).

CDMA (Code Division Multiple Access) The CDMA is based on spread spectrum technology which uses the whole bandwidth available. This allows each user to transmit frequency to the entire spectrum at all the time. CDMA uses a type of digital modulation called spread spectrum. CDMA spreads the voice data over the channel in a random fashion. The receiver undoes this randomization and collects the bits together to produce the sound. CDMA is an example ofmultiple accesses, in which several transmitters can send information over a single communication channel at the same time. This allows several users to share a band of frequencies (Andrew J, 1995).

GSM phones emit continuous wave pulses, so there is a great need to reduce the exposures to electromagnetic fields emitted from the cell phones with “ continuous wave pulses”. On the other hand CDMA cell phones do not produce these pulses. GSM phones emit about 28 times more radiation when compared to the CDMA mobile phones. Therefore, GSM phones are more biologically harmful as compared to CDMA.

Subtle deleterious effects to hearing can be assessed by modalities such as BERA, otoacoustic emission (OAE) and Pure tone audiometry, which measure the cochlear and retrocochlear , outer hair cochlear cell and middle ear functions respectively.

In the evaluation of the functional status of auditory nerve and brainstem auditory sensory pathwayBrainstem Auditory Evoked Responseis a simple

and effective method. It is a noninvasive and reproducible method that requires less cooperation of patient and measures the specific part of the auditory pathway. It is not significantly affected by state of consciousness, drugs and variety of environmental factors including other sensory inputs to cortex. BERA is an objective diagnostic tool widely used in modern neurophysiology. It represents the electrical events generated along the auditory pathway which is recorded from the scalp. These responses include several waves related to the specific areas of auditory pathway. Latencies of these waves reflect the neural conduction velocity at corresponding levels of auditory brainstem.

Pure toneaudiometry(PTA) is the keyhearing testused to identifyhearing threshold levels of an individual, enabling determination of the degree, type and configuration of ahearing loss. Thus, it provides the basis for diagnosis and management. PTA is a subjective, behavioral measurement of hearing threshold, as it relies on patient response topure tonestimuli. Therefore, PTA is used on adults and children old enough to cooperate with the test procedure.

The initial laboratory exploration of OAEs coincided with, and contributed to, the rapid development of a new understanding of cochlear function. Numerous experiments have demonstrated that OAE are intimately associated with a key feature of the cochlear mechanism that has become known as the “ cochlear amplifier”(Cooper NP, 1997). With OAEs it is possible to demonstrate cochlear mechanical frequency selectivity and nonlinearity and to observe the depression of cochlear activity caused by noise, drugs and medial olivocochlear stimulation.

AIMS AND OBJECTIVES

This study is designed to evaluate the potential effects of electromagnetic field of mobile phones on human ear.

1. Assessment of hearing threshold by pure tone audiometry and there comparison in users and non-users.
2. Assessment of auditory pathway by Brainstem Evoked Response Auditory (BERA), and there comparison in mobile phone users and non-users.
3. Assessment of cochlear function by recording the otoacoustic emissions produced from outer hair cells of inner ear, and there comparison in mobile phone users and non-users.