

AUDIOLOGICAL DISTURBANCES IN CHRONIC MOBILE PHONE USERSNaveen Sharma¹, Uma Garg², Deepak Verma^{3*} and Sandeep Ranjan⁴¹Naveen Sharma, Department of Otorhino Laryngology, BPS Government Medical College for Women, Khanpur Kalan, Haryana, India.²Uma Garg, Department of Otorhino Laryngology, BPS Government Medical College for Women, Khanpur Kalan, Haryana, India.³Deepak Verma, Department of Otorhino Laryngology, BPS Government Medical College for Women, Khanpur Kalan, Haryana, India.⁴Sandeep Ranjan, Department of Otorhino Laryngology, BPS Government Medical College for Women, Khanpur Kalan, Haryana, India.***Correspondence for Author: Deepak Verma**

Deepak Verma, Department of Otorhino Laryngology, BPS Government Medical College for Women, Khanpur Kalan, Haryana, India.

Article Received on 07/08/2016

Article Revised on 27/08/2016

Article Accepted on 17/09/2016

ABSTRACT

Objectives: To study the effects of long term exposure to electromagnetic waves emitted from mobile phones on auditory functions. **Methods:** The study included 50 mobile phone users between the age group of 17 to 42 years with decreased hearing as chief complaint. The use of mobile phone is so common that we couldn't find non-users as a control group. Therefore we compared the non-dominant ear to the dominant ear using audiometric measurements. Detailed evaluation included thorough case history through questionnaire, Otosopic clinical examination followed by Pure Tone Audiometry & Impedance Audiometry. Comparison was made between total exposure duration with associated symptoms & with pattern of hearing loss. **Results:** We found significant hearing loss in the dominant ear as compared to non dominant ear in our study, ranged from minimal to severe based upon the duration of exposure. Definite patterns of hearing loss were observed, with high frequencies affected initially and followed by hearing loss at lower frequencies. **Conclusion:** This study concluded that prolonged use of mobile phones predispose to auditory disturbance in terms of hearing loss in the dominant (exposed) ear and it was found to be correlated with the duration of usage and length of years using mobile phones.

KEYWORDS: Mobile phones, Electromagnetic radiation, High frequency hearing loss.**INTRODUCTION**

The wide spread use of mobile communication since late 1980's raises questions about the hazardous effects of electromagnetic fields (EMFs) on the human body. Mobile phones transmit and receive signals using electromagnetic fields in the radiofrequency band. The Global System for Mobile Communications (GSM) is currently the most widely used digital mobile phone service operating at 900 to 1,800 MHz frequency bands.^[1] The studies have concentrated on the non thermal effects of electromagnetic radiation (EMR). Low energy EMFs seem to cause structural and functional changes in the cell membrane of different cell types, leading to abnormal electrophysiological cell response. Such changes within the cells of central nervous system (CNS) and auditory system, which directly receive EMR during mobile phone use, are of particular interest. Therefore, it is hypothesized that this causes effect on the neurotransmission & possibly hearing loss. But no final conclusions can be drawn regarding the potential harmful effects of mobile phone use. Experiments are underway to investigate possible adverse effects of mobile phone

use on the auditory system and the CNS. Therefore more studies are expected to clarify whether mobile phone use truly presents a health hazard.

More & more mobile base stations have led to wide ranging concern about possible health effects of radiofrequency emissions. There are two distinct possibilities by which health could be affected as a result of radio frequency field exposure. These are thermal effects caused by holding mobile phones close to the body and extended conversations over a long period of time. Secondly, there could be possibly non thermal effect both from phones and base stations whereby the effects could also be cumulative to the people staying in that area.

Several studies have been conducted to assess the effect of mobile phone on hearing. Various reports suggest that mobile phone use can cause health problems like fatigue, headache, dizziness, tension and sleep disturbances.^[2-5] However, only limited data is available in medical literature regarding correlation between electromagnetic

fields emitted by mobile phones use and effects on human auditory nervous system and on auditory acuity.

According to a recent study done at PGIMER, Chandigarh concluded that the cell phone use exceeding 60 minutes per day could result in auditory damage such as high frequency hearing loss.^[6] Those with high frequency hearing loss cannot hear sounds ranging from 2,000 to 8,000 Hertz, which can affect the ability to understand speech and discern consonants. This study was aimed to at understand the auditory effects of long term mobile use.

MATERIALS AND METHODS

This study was conducted in department of Otorhinolaryngology & Head and Neck surgery in a tertiary centre. The study included 50 subjects using mobile phone for at least a year and presented with decreased hearing as primary complaint. Among these, 44 were males and 6 females with age ranged from 17 years to 42 years and with mean age of 26.76 years. The volunteers in the study group comprised of students, staff and well educated general population who easily understood the process. The use of mobile phone is so common that we were unable to find non-users as a control group. Therefore we compared the non-dominant ear to the dominant ear using audiometric measurements. The subjects with family history of hearing loss, old age patients with presbycusis, previous history of significant loud noise exposure, with bilateral hearing loss, any systemic illness contributing to hearing loss and any type of middle ear pathology were excluded from the study.

Users of Bluetooth and hands-free devices were also excluded. All the participants were subjected to a questionnaire relating to details of hearing loss. It included following points:

- 1) Onset of hearing loss along with its progressive nature if any
- 2) Asked about the dominantly used ears for mobile communication
- 3) Average time of mobile use per day and the total duration of mobile use in 1 year approximately
- 4) Use of head phone if any
- 5) Occupational exposure to loud noise
- 6) Any associated complaint with hearing loss like tinnitus, dizziness
- 7) Detailed history regarding any ear trauma, ear discharge
- 8) Past history of any kind of ear surgery
- 9) A note of tobacco addiction by the patients in various forms was recorded

After the questionnaire, detailed clinical examination including ear examination with otoscope was done. The normality of tympanic membrane was assured before taking patients for further investigations. All the subjects underwent a Pure tone audiometry (PTA), followed by with Impedance audiometry to rule out any middle ear pathology. Pure tone audiometry was done at frequencies

of 250, 500, 1,000, 2,000, 4,000, 8,000, 10,000 and 12,000 Hz. Subjects were considered to have normal hearing if Pure Tone audiometry showed hearing loss not exceeding 20 dB between 250 and 12,000 Hz and classified as having hearing loss if any of the hearing thresholds are above 20 dB between 250 and 12,000 Hz. In Impedance audiometry, only Type 'A' graph was taken into consideration in the study to rule out any other type of pathology of middle ear. Pure tone audiograms were assessed for type and pattern of hearing loss. Detailed frequency wise hearing threshold estimation was studied.

RESULTS

A total of 50 patients were included in the study. Out of these, 44 were males and 6 were females. Age ranged from 17 years to 42 years with mean age of 26.76 years. All the subjects presented with chief complaint of decreased hearing. 22 subjects also had complaints of tinnitus, dizziness was present in 7 subjects (Fig. 1). Out of the 7 subjects with dizziness, 4 had dizziness associated with tinnitus and 3 subjects had only dizziness without any tinnitus. The right ear was dominant in 27 (54%), 15 (30%) were dominant in the left ear and 8 (16%) did not have a preference (Fig.2).

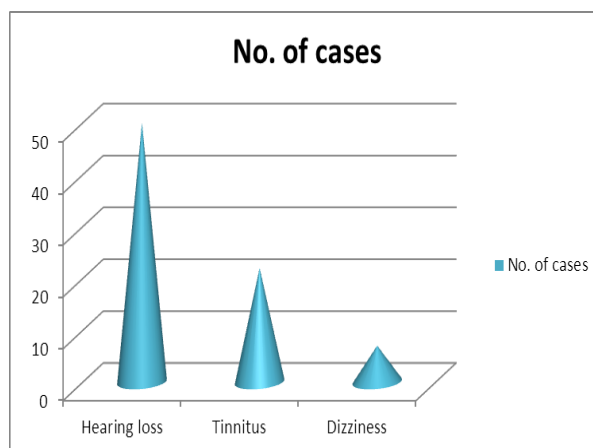


Figure 1: Showing distribution of symptoms of the subjects in the study

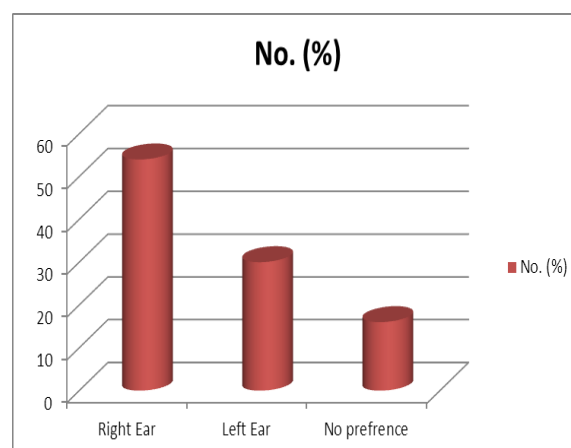


Figure 2: Showing dominance of ear in the study group

On audiological evaluation (PTA) of 50 subjects, 48 patients were found to have hearing loss while 2 patients had hearing sensitivity within normal limits. Significant hearing loss was observed in the dominant ear as compared to non dominant ear and those with no preference in using mobile phone in our study. The hearing loss ranged from minimal to severe based upon the duration of exposure. As far as total duration of exposure to mobile phone is considered the patients were divided into 6 groups. Total duration was calculated by multiplying the average use of mobile/ day with total duration in 1 year.

Overall exposure duration of mobile phone used in hours in a year has been classified as follows:

Less than 400 Hrs: There were 04 patients in this category and among these 4 patients, 2 had normal hearing and 2 patients had gradual sloping hearing loss.

401 Hrs to 1000 Hrs: There were 11 patients in this category. All patients had hearing loss. 6 patients (55%) had gradual sloping pattern and 5 (45%) had flat pattern of hearing loss.

1001 Hrs to 2000 Hrs: There were 16 patients in this category and all had hearing loss. High frequency sloping pattern of hearing loss was seen in 11 patients (69%) and flat pattern was observed in 5 patients (31%).

2001 Hrs to 3000 Hrs: 6 patients were seen in this category and all of them had hearing loss. 3 patients (50%) had gradual sloping pattern of hearing loss and 3 (50%) exhibited flat pattern of hearing loss.

3001 Hrs to 4000 Hrs: There were only 2 patients in this category and both of them showed gradual sloping pattern.

More than 4000 Hrs: 11 patients were seen in this category and all had hearing loss. 5 patients (45%) had gradual sloping hearing loss while 6 patients (55%) showed flat audiometric pattern.

It was observed that as chances of hearing loss increased with increase in total duration of exposure. Only 2 patients with duration of exposure less than 400 hrs had normal hearing. This indicates that probably mobile use less than one hour per day is safe and after that with the increase in duration of exposure, there are chances of developing sensory neural hearing loss

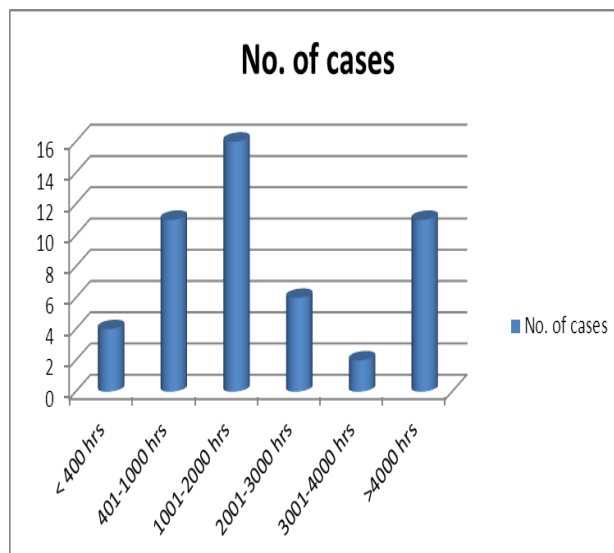


Figure 3: Showing duration of exposure (in hours) in the study group

On studying the distribution of pattern wise hearing loss, we found high frequency sloping hearing loss in 29 patients (60%) and flat pattern of hearing loss in 19 patients (40%). The possible explanation is that initially with mobile exposure the hearing loss starts in high frequencies and subsequently involving other frequencies also to become flat as seen in our study.

DISCUSSION

With the rapid development of mobile technology & tremendous usages of mobile phones essentially in all fields of life, there is associated public concern regarding potential damage caused by EMF emitted by mobile phones. Mobile phones generate electromagnetic radiation in two ways, first from the antennae present around our towns and secondly from the telephones themselves. Present international standards permit GSM 900 mobile phones to transmit at a pulsed power of 2 W with an average output of 0.25 W.^[7] The exposure of mobile users to EMF can be quantified in terms of amount of energy absorbed by a unit mass of the object, which is expressed as the specific absorption rate (SAR) with units of W/Kg. The inner ear being in the closest proximity to the mobile phone during use, leads to relatively high SAR deposition as compared to the rest of body. The delicate hair cells in the organ of Corti do not have regenerative properties, thus in advanced stages damages are often permanent with little chance of recovery. Only limited research data concerning harmful interaction between mobile phone exposure and the inner ear is available in the literature.

Analysis of the possible detrimental effects of mobile use on different systems of living organisms including human beings is a herculean task. Various research articles published in this regard so far have failed to establish a definite mechanism of impaired auditory & cognitive functions in the mobile users. Uloziene et al^[8] conducted a double blind study to assess the effects of

electromagnetic emissions on the hearing. The study & control group underwent PTA and TEOAE testing before and 10 minutes after mobile phone exposure. No significant difference was observed between control and user groups. Study by Oktay and Dasdag^[9] of Department of Otolaryngology, medical school of Diyarbakir, Turkey, to investigate the effects of radiations emitted by mobile phones on the hearing of users, showed that higher degree of hearing loss is associated with long term exposure to electromagnetic field generated by cellular phones. Another study was conducted at Kasturba Medical College, Manipal by Hedge et al^[10] in 2013 to investigate the effect of mobile phone on hearing. Effect on hearing in 120 mobile phone users & non users between age group of 18-30 years were studied over 3 years. Those using phones for 2-3 hours daily, loss of 5 dB in 10%, 10 dB in 3.3% and 15 dB in 1.6% were noted. Also loss of 5 dB in 6.6% 10 dB in 3.3% was noted in those using 3-4 hours daily. Sensorineural hearing loss was seen in 26.6% of the subjects in study group & 3.3% in control group.

The European multicenter project named GUARD involved aimed to assess potential changes in auditory function as a consequence of exposure to low intensity electromagnetic fields (EMFs) produced by GSM cellular phones.^[5] Auditory function was assessed immediately before and after exposure to EMFs (Exposure was given for 10 min) and only the exposed ear was tested. The tests used for the assessment of auditory function were hearing threshold level (HTL), transient otoacoustic emissions (TEOAE), distortion product otoacoustic emissions (DPOAE) and auditory brainstem response (ABR). The results of this project showed that exposure to GSM mobile phone signals had no effect on the auditory system as the exposure was given only for 10 minutes. While our study focus on the effects of chronic exposure on the auditory function.

The absorption of EMFs is more on the side the phone is held and decreases to one-tenth on the opposite side of the head. Thus the dominant ear receives maximum electromagnetic rays. On the basis of this concept, we were able to conclude that the dominant ear has significant hearing loss as compared to the other non-dominant ear. We also found that the longer the duration of use, both in term of daily usage and length of years using mobile, the more significant the hearing loss.

CONCLUSIONS

Hearing loss in mobile users ranged from minimal to severe based upon the duration of exposure. Definite patterns of hearing loss were observed, with high frequencies affected initially and followed by hearing loss occurred at lower frequencies. Our study showed that prolonged use of mobile phones predispose to auditory disturbance in terms of hearing loss and it was found to be correlated with the length and duration of usage of mobile phones. Therefore, it is suggested that

the use of mobile phone may be a risk factor for hearing and excessive use should be avoided.

REFERENCES

1. Mostafapour SP, Lahargoue K. Noise induced hearing loss in young adults. *Laryngoscope*, 1998; 108(12): 1832–1839.
2. Garcia Callejo FJ, Garcia Callejo F, Pena Santamaria J, Alonso Castaneira I, Sebastian Gil E, Marco Algarra J. Hearing level, intensive use of mobile phones. *Acta Otorrinolaringol*, 2005; 56(5): 187–191.
3. Monnery PM, Srouji EI, Bartlett J. Is cochlea outer hair cell function affected by mobile telephone radiation? *Clin Otolaryngol Allied Sci*, 2004; 29(6): 747–749.
4. Ozturan O, Erdem T, Miman MC, Kalcioğlu MT, Oncel S. Effects of mobile telephone's electromagnetic field on hearing. *Acta Otolaryngol*, 2002; 122(3): 289–293.
5. Parazzini M, Brazzale AR, Paglialonga A, Tognola G, Collet L, Moulin A et al. Effects of GSM cellular phones on human hearing: the European project "GUARD". *Radiat Res*, 2007; 168: 608–613.
6. Panda NK, Jain R, Bakshi J, Munjal S. Audiological disturbances in long-term mobile phone users. *J Otolaryngol Head Neck Surg*, 2007; 137: 131-2.
7. Loughran SP, Wood AW, Barton JM, Croft RJ, Thompson B, Stough C. The effects of electromagnetic fields emitted by mobile phones on human sleep. *Neuroreport*, 2005; 16(17): 1973–1976.
8. Uloziene, I., Uloza, V., Gradauskiene, E. et al. *BMC Public Health*, 2005; 5: 39. doi:10.1186/1471-2458-5-39.
9. Oktay MF, Dasdag S. Effects of intensive and moderate cellular phone use on hearing function. *Electromagn Biol Med*, 2006; 25: 13-21.
10. Hegde MC, Shenoy VS, Kamath PM, Rao RA, Prasad V, Varghese BS. Mobile phones: Its effect on hearing. *Indian J Otol*, 2013; 19: 122-6.