

Effect of Electromagnetic Radiations Emitted From Mobile Phones on Hearing Threshold: An Assessment By Pure-Tone Audiometry.

Gaurav Sharma¹, D.K. Agrawal², S.A. Hasan³

¹Senior Resident, Department of Physiology, J.N. Medical College, AMU, Aligarh.

²Professor, Department of Physiology, J.N. Medical College, AMU, Aligarh.

³Professor, Department of Otorhinolaryngology, J.N. Medical College, AMU, Aligarh.

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ABSTRACT

Background: Mobile phones are the necessity in modern life. The exposure to electromagnetic field emitted by mobile telephones causes side effects, which may be thermal and non-thermal side effects. **Methods:** Thirty non-user participants and sixty user participants (who use mobile phones for more than 1 hour for more than 2 years) were included in the study. Users participants were further sub-divided into Group A (which use mobile phones for more than 1 hours for more than 2 years but less than 5 years) and Group B (who use mobile phones for more than 1 hours for more than 5 years). Hearing threshold of the subjects was assessed by Pure Tone Audiometry (PTA). **Results & Conclusion:** There was increased hearing threshold of hearing in mobile phone users as compared to non-users. These changes suggest that radiations emitted from mobile phone causes damage to hearing apparatus of the ear. The study shows that mobile phones have a detrimental effect on the human hearing threshold.

Keywords: Mobile Phones, Pure-tone Audiometry, Hearing Threshold.

INTRODUCTION

Mobile phones have become indispensable as communication tools in the present world. 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 various harmful effects on humans.^[1]

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 radiations from mobile phones cause sensation of warmth and burning around the ear.^[2] Various studies have shown that mobile phones cause headache,^[1] sleep disturbance,^[3] changes in the cognitive functions and neural activity.^[4,5] Electromagnetic frequencies emitted from mobile phones causes increased incidence of brain tumour and acoustic neuroma.^[6] There is significant increase in occurrence of acoustic neuroma in persons using mobile phones for more than 10 years.^[7] Acoustic neuroma is a benign tumour on the auditory nerve that usually grows slowly over a period of years before it is diagnosed. 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. Till date, the interaction between electromagnetic fields (EMF) emitted by mobile phones and auditory function is not well established.

Pure tone audiometry (PTA) is the key hearing test used to identify hearing threshold levels of an individual, enabling determination of the degree, type and configuration of a hearing loss. Thus, it provides the basis for diagnosis and management. PTA is a subjective, behavioural measurement of hearing threshold, as it relies on patient response to pure tone stimuli.

Name & Address of Corresponding Author

Dr. Gaurav Sharma
Senior Resident,
Department of Physiology,
J.N. Medical College, AMU, Aligarh.

MATERIALS AND METHODS

Sixty participants (mobile phone users) and thirty participants (non-users) were recruited for the study. The users were asked about the use of mobile phones by right ear or left ear. Most of the users reported use of only one ear throughout the call, consistently. Those users who reported equal use of both ears were excluded from the study. Though the number of users and non-users in the study is unequal but the

total number of radiation exposed ears and total number of unexposed ears (two ears per non-user) is equal, as nonuser participants have not used mobile phone from any ear.

User group: Sixty healthy participants of age group 18-40 years were taken in this group. They were further divided into two sub groups.

They were as under:

Group A: Thirty participants using mobile phone for more than two years but less than five years and for more than one hour per day.

Group B: Thirty participants using mobile phone for more than five years and for more than one hour per day were included in this group.

Non-user group: Thirty participants who were not currently using mobile phones OR only seldom used mobile phones, i.e., less than 10 min per day for less than one year were grouped in non-user group.

User participants were recruited from among males and females in the age group of 18-40 years. The user participants were adults in the specified age groups using mobile phones for not less than two years duration. The participants chosen had good general health without any known medical conditions or any significant past medical (diabetes and hypertension) or psychiatric history. There was no history of otalgia, discharging ear, ear surgery, any history or diagnosis of head and neck tumour(s) or any other known otological diagnosis. There was no history of prolonged usage of ototoxic drugs among them.

Non-user participants chosen were age matched with the above mentioned inclusion criteria. The non-user participants also had no significant medical history and were free from any clinically apparent ear complaint(s).

The information regarding the use of hands-free devices, duration of use and exposure time per day, use of which ear predominantly (left ear or right ear) and medical and/or otological morbidities were recorded. Duration for which hands-free set was used was deducted from the total duration of usage. Eligible participants were subjected to pure tone audiometry (PTA)

The audiometry was performed by MAICO MA33 audiometer. Test was done in a sound proof and silent room and all the recordings were taken by one person only. Audiometer has the main audiometer box, which was connected to the LENOVO THINKPAD E430 laptop, headphones, bone oscillator and a subject response switch.

Each subject was tested for air conduction and then for bone conduction of the ear. The subject was presented with a series of soft tones, therefore subject was asked to pay attention. As soon as the tone is heard, even very soft, subject was asked to respond by pressing the subject response switch. Response recording was made from 500 Hz to 4k Hz for air conduction and bone conduction. Test was started at 1k Hz, and then to 2k Hz, and then

returning to lower frequency of 500 Hz. Lowest intensity (in dB) of the sound which can be heard by the subject, at a given frequency (in Hz) was recorded. 10 up 5 down rule of audiometry was used to record the correct threshold of hearing of the subject.

For air conduction testing: high quality, padded headphones were placed over the subject's ear, such that headphones completely cover the ear. Red earphone was placed over right ear and blue earphone over left ear.

For bone conduction testing: procedure of the testing was same as air conduction testing except for that in place of headphones, bone oscillator was used. Bone oscillator was placed over the mastoid process, behind the ear to be tested.

The hearing assessment of each ear was done for air conduction and bone conduction. Ideally, both graphs should overlap. The difference between the air conduction and bone conduction was measured in dB at various frequencies. Average of the gap between air conduction and bone conduction at 500 Hz, 1 kHz, and 2 kHz was calculated. This average was used to grade the subjects in groups of normal, mild hearing loss, moderate hearing loss, severe hearing loss, and profound hearing loss.^[8]

Descriptor	Average hearing threshold levels (dB HL)
Normal hearing	Less than 20
Mild hearing loss	20-40
Moderate hearing loss	41-70
Severe hearing loss	71-95
Profound hearing loss	In excess of 95

Data Analysis

Data analysis was done using the SPSS software version 22.0. Pure-tone audiometry results were graded into 5 grades: Normal; Mild hearing loss; Moderate hearing Loss; Severe hearing Loss and Profound hearing loss as per guidelines of British Society of Audiology. The results of users and non-users were compared by chi-square test. Probability (p) value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of the results of the pure tone audiometry of cases (Group A +Group B) to controls.

Hearing assessment	Control (No. of individuals)	Cases (No. of individuals)
Normal	51	39
Mild	08	19
Moderate	01	2
Severe	00	00
Profound	00	00
Total	60	60

Chi square test was applied for the above data (excluding data for severe and profound hearing loss, as chi-square cannot be applied, if zero appears in both the tables for a particular category) and p value was <0.05 (significant)

Table 2: Comparison of the results of the pure tone audiometry of cases Group A to the control.

Hearing assessment	Control (No. of individuals)	Cases (Group A) (No. of individuals)
Normal	51	20
Mild	08	09
Moderate	01	01
Severe	00	00
Profound	00	00
Total	60	30

Chi square test was applied for the above data (excluding data for severe and profound hearing loss, as chi-square cannot be applied, if zero appears in both the tables for a particular category) and p value was >0.05

Table 3: Comparison of the results of the pure tone audiometry of cases Group B to the control.

Hearing assessment	Control (No. of individuals)	Cases (Group B) (No. of individuals)
Normal	51	19
Mild	08	10
Moderate	01	01
Severe	00	00
Profound	00	00
Total	60	30

Chi square test was applied for the above data (excluding data for severe and profound hearing loss, as chi-square cannot be applied, if zero appears in both the tables for a particular category) and p value was <0.05

DISCUSSION

Mobile phones have become a part of modern life style. There has been rapid boom in the number of mobile phones in the recent decade. This rapid worldwide expansion of mobile telephones raises questions regarding possible effects of the emitted radiofrequencies on the health of the consumers. The electromagnetic waves can affect the human health ranging from headache, extreme irritation, increase in the carelessness, forgetfulness, decrease of the reflex and clicking sound in the ears.^[9] Of all the anatomical structures, the ear is in the closest proximity to the mobile phones, hence most potential organ system to be damaged by the electromagnetic waves emitted from the mobile phones.

Pure tone audiometry is a key hearing test for assessment of hearing threshold of the individual. It determines the degree of hearing loss and also type and configuration of hearing loss. Pure tone audiometry uses both air and bone conduction

audiometry, the type of loss can be identified by the air-bone gap

In our study, while comparing the results of pure tone audiometry in controls (n=60) and total cases (n=60), it was found that in control group 51 individuals had normal hearing threshold, 08 had mild hearing loss and 01 had moderate hearing loss. Of the total cases, 39 had normal hearing threshold, 19 had mild hearing loss and 2 had moderate hearing loss. No individual in the cases or control group had severe or profound hearing loss. Chi square test with Yates correction was applied for statistical analysis of the data, and difference was found to be significant (p value<0.05).

While comparing, sub groups of cases (group A, Group B) to controls for pure tone audiometry, it was found that in group A (n=30) 20 individuals had normal hearing threshold, 09 had mild hearing loss and 01 had moderate hearing loss. While in group B, 19 had normal hearing threshold, 10 had mild hearing loss and 01 had moderate hearing loss. Chi square test with Yates correction was applied for statistical analysis of the data, and difference was significant (p value<0.05) for group B, but was insignificant (p value>0.05) for group A.

Hegde MC et al^[10] reported that there is no significant hearing loss in mobile phones users as compared to non- users when assessed by pure tone audiometry.^[10]

Kerekhanjanarong V et al subjected 98 mobile phone users to audiometry,^[11] tympanometry, otoacoustic emission (OAE) and auditory brain stem evoked response (ABR). When they compared the audiogram, both pure tone and speech audiometry, between the dominant and non-dominant side, it indicated that there is no significant difference. When they focused on the eight subjects that used the mobile phone for more than 60 minutes per day, they found that the hearing threshold of the dominant ears was worse than the non-dominant ear. Oktay MF et al^[12] studied the effects of mobile phones on hearing by pure tone audiometry and brainstem evoked audiometry response.^[12] They reported a high frequency hearing loss in subjects exposed to electromagnetic frequencies of mobile phones when assessed by pure tone audiometry. Panda NK et al,^[13] reported high frequency hearing loss in long term mobile phone users as compared to non-users.

Godson R. E. E. Ana et al^[14] by their study gave the results that hearing impairment was higher in those reporting longer duration of mobile phone use.

Patel H et al^[15] by pure tone audiometry,^[14] found that there is increased degree of hearing loss in long term mobile phone users than control subjects with mean hearing loss was more in dominant ear compared to non-dominant ear.^[15]

Results of pure tone audiometry, in present study show that use of mobile phones has detrimental effect on hearing threshold. Results also show that

longer the duration of mobile phone usage, more is the damage to the ear. The results are in concurrence with the other similar studies done in our country and abroad.^[11-15]

CONCLUSION

On comparison of results of pure-tone audiometry (PTA) in total user ears (n=60) and non-user ears (n=60), a significant increase in the hearing threshold was observed. Similar results were seen when Group B users were compared to non-users. Group A had no significant change in the hearing threshold. Thus from this study we conclude that, electromagnetic radiations of mobile phones have detrimental effects on human hearing threshold. Further, the damage to the ear is proportional to the amount of exposure.

However, amount of damage and safety limit for use of mobile phones cannot be effectively extrapolated from this study alone and future prospective research in required to define the safe hours , safe methods of use and to reduce the emissions of these radiations from mobile phones.

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