AN EVALUATION OF HEARING AMONG MOBILE PHONE USERS

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ABSTRACT

Since its introduction in the 1983, the use of mobile phones is becoming increasingly popular and almost indispensable in modern day life and it is one of the fastest growing technological developments of our times, but there are many adverse biological effects of microwave radiation. Radio frequency electromagnetic radiations are emitted from mobile phone antennae and their base stations. The radiofrequency from the mobile phones travels through the external ear to reach the peripheral auditory system and finally to the central auditory system, leading to high energy deposition making it the most affected target organ. This study was done to analyze the auditory thresholds shift at frequencies from 500 to 8,000 Hz of the mobile phone users at Nepal Medical College and Teaching Hospital. This comparative cross-sectional study was done by testing the hearing thresholds from 500 to 8,000 Hz. Two hundred four subjects were evaluated. Subjects were tested with conventional audiometry. Results showed that there were significant differences in auditory thresholds of the dominant ear, right ear in our case, of the subjects at the frequencies of 1 KHz, 2 KHz and 8KHz. Therefore, we concluded that the auditory threshold shift in the dominant ear is due to use of mobile phone.

KEYWORDS

Auditory, hearing loss, mobile phone, threshold shift

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INTRODUCTION

The use of mobile phone has spread very rapidly and widely since its availability in 1983. It was estimated that there were more than 2.14 billion mobile phone users in the world till 2005, which increased to 6.88 billion mobile phone users worldwide in 2013. There are total of 18 million phone users among total Nepalese population at present.[1]

Mobile phones transmit and receive signals using electromagnetic fields in the radiofrequency band through the antennae that are present around our towns and the phone itself. 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.[2] The international standards permit GSM 900 mobile phones to transmit at a pulsed power of 2W with an average output of 0.25 W.[3]

Mobile Phones emit the radiofrequency which are below the guidelines of the International Commission on Non Ionizing Radiation Protection (ICNIRP). These radiofrequencies are not sufficiently energetic to destabilize electron configuration so it cannot produce the genotoxic effects such as DNA mutations.[4] But the data on its long term effects is sadly lacking.

The radiofrequency from the mobile phones travels through the external ear to reach the peripheral auditory system and then to the central auditory system, leading to high energy deposition making it the most affected target organ of thermal and non-thermal effects.

The auditory system and particularly the cochlear outer hair cells (OHC) are known to be highly sensitive to a great variety of exogenous and endogenous agents. Hair cells are known to be sensitive to chronic exposure as well. The externally applied electric and magnetic fields are known to be able to produce some hearing sensation.[5] Moreover, the delicate hair cells in the organ of Corti do not have regenerative properties, thus damages are often permanent with little chance of recovery in advanced stages. Therefore, the ear is at risk of exposure to noise from the mobile phone as well as its electromagnetic radiation.

This study was done to evaluate the hearing threshold of mobile phone users.

MATERIALS AND METHODS

This comparative cross-sectional study was performed in Nepal Medical College Teaching Hospital from November 2016 to October 2017. A total number of 204 subjects of both sexes in the age group of 19-46 years who were using mobile phones for at least 8 years were selected.

The physical and otoscopic examinations were performed by ENT surgeon to rule out any external or middle ear pathology that could affect hearing. Subjects with known family history of hearing loss, history of chronic ear disease, recent upper respiratory infection, meningitis, head injury, occupational persistent noise, exposure to ototoxic drugs and loud noise, history of any chronic medication, users of bluetooth and subjects with bilateral hearing loss were excluded.

We were not able to find non mobile users as controls thus, as almost all of the subjects were using the mobile phone on only one ear (the dominant ear), we used the dominant ear as the study group and the non dominant ear as control. The dominant ear has also been used by other studies. [22, 23]

The informed consent was taken. Ethical clearance was obtained from institutional ethical committee.

The hearing levels of subject were tested by AD 229 b, Interacoustic Pure tone audiometer (PTA).Audiometry was performed by an experienced audiologist at frequencies of 250, 500, 1000, 2000, 4000 and 8,000 Hz. Subjects were considered to have normal hearing if verified by PTA to have no loss exceeding 25 dB between 250 and 8,000 Hz and classified as having hearing loss if any of the hearing thresholds were above 25 dB in any frequencies.

All subjects in this study used GSM 2G and 3G mobile phones. The study was single blinded, as the audiologist did not know which was the dominant ear. The audiograms were examined.

RESULTS

Two hundred four subjects were enrolled in the study. Among them, 140 (68.6%) were males and 64 (31.4%) were females. The age of the subjects was between 19 and 46 years. The mean age was 32.28 years with standard deviation of 7.96.

All the subjects used their right ear, the dominant one while using mobile phone.

Duration of mobile use in all the subjects was more than 8 years. The duration of mobile phone use per day varied from thirty minutes to three hours with the mean of 1.48 hours with standard deviation of 0.506.

The subjects were further categorized into two groups: those who used the mobile phone less than mean value of 1.5 hours per day and those who used for more than 1.5 hours per day. The hearing loss between these groups was compared.

The auditory threshold at all frequencies of both the ears were within normal limit in both the groups, but when we analyze auditory threshold for the individual frequencies, we noticed that the auditory threshold was progressively increased in the higher frequencies and even more in the group of subjects who used it more than 1.5 hours per day.

When we compared the two groups in the left ear, we noticed that though the frequencies were within

normal limit, the auditory threshold progressively increased with the increase of the frequencies and moreover it was more for the group of subjects who used the mobile for more than 1.5 hours.

In the right ear also, the auditory threshold were increased as the frequencies increased, and when we compare the two groups, the thresholds increased significantly in the subjects who used the mobile phone for more than 1.5 hours in the frequencies of 1KHz, 2KHz and 8KHz. **Table 1**

Table 1: Comparison of hearing thresholds in all frequencies between groups in both ears.

Frequency	Left Ear					95% Confidence interval of the difference		Right ear					95% Confidence interval of the difference	
	<1.5 hrs		Over 1.5 hrs					<1.5 hrs		Over 1.5hrs				
	Mean	SD	Mean	SD	p	Lower	Upper	Mean	SD	Mean	SD	p	Lower	Upper
250HZ	13.22	2.40	13.93	2.40	.032	-1.370	-0.062	12.25	2.50	12.13	2.49	.752	-0.599	.829
500HZ	12.21	2.49	12.47	2.51	.479	-0.974	0.459	12.48	3.13	12.27	2.50	.614	-.622	1.050
1KHZ	12.13	3.41	12.40	2.51	.554	-1.159	0.623	12.36	2.50	13.47	2.32	.002	-1.801	-0.404
2KHZ	11.82	2.86	12.47	3.32	.145	-1.515	0.225	11.71	2.38	12.93	3.09	.002	-1.990	-0.466
4KHZ	19.69	3.52	20.16	4.33	.204	-1.809	0.389	13.41	3.12	14.53	3.96	.026	-2.111	-0.134
8KHZ	20.16	4.59	21.73	4.69	.020	-2.903	-0.254	12.83	3.11	14.53	4.44	.002	-2.751	-0.657

DISCUSSION

The auditory system is the first biological structure to be entered by the electromagnetic radiations from mobile phones. Generally, the effects of noise on hearing were described as acoustic trauma, temporary threshold shift and permanent threshold shift.

A permanent threshold shift of hearing is defined as hearing loss that, once it occurs, is permanent and irreversible. It may be small amounts of permanent damage result from many noise-induced temporary threshold shifts.[24] Permanent threshold shifts may be cumulative effects of small noise exposures that are repeated over a period of many years.[25]

Even though, the use of mobile phones is becoming increasingly popular and almost indispensable in modern day life and it is one of the fastest growing technological developments of our times, there are many adverse biological effects of microwave radiation. Radio frequency electromagnetic radiations are emitted from mobile phone antennae. These can penetrate organic tissue and be absorbed and converted into heat. These effects depend on factors like: the duration of the irradiation, the rate of absorption and the distribution of electromagnetic radiation energy by different tissues of the body and individual characteristics of the central nervous system and immune systems.[11, 26]

The close proximity of a mobile to ear may lead to the deposition of a large amount of electromagnetic radiation energy in the ear.[27]

There have been numerous studies on electromagnetic radiation from mobile phones and its effects on public health.[6,7,9-12,21]

In various comparative study, pure tone thresholds were analyzed in mobile phone users and non-users, and the significant difference was noted, even though thresholds were normal.[9] In a study done to see the effects of mobile phone use on hearing function on frequencies between 500 to 4,000 Hz, concluded that the hearing loss was associated with long-term exposure to electromagnetic fields generated by mobile phones.[10]

The ear that is frequently used for the mobile, is identified as the dominant ear,receives maximum electromagnetic radiations. Electromagnetic absorption is maximum on the dominant side where the phone is held and decreases to one-tenth on the opposite side of the head.[28] In our study, the hearing loss was significantly observed in mobile users in the right ear in certain frequencies. So, we were able to conclude that the dominant ear has significant hearing loss compared to the non-dominant ear in certain frequencies.

The subjects using mobile for more than 1.5 hours daily for 8 years and more, had increased auditory threshold in the right ear in the frequencies of 1KHz, 2KHz and 8KHz, thus indicating that the hearing loss depends on duration of exposure. In a study done in 873 subjects of Saudi population, Meo and Dress found impaired hearing with earache and earache and/ or warmth on the ear in 34.59%.[29] Likewise, Garcia C *et al.* noted mild hearing loss in 323 mobile phone users for 3 years, which was not statistically significant.[6] Oktay MF *et al* observed that auditory thresholds in those who talked approximately 2 hours per day were found to be higher than those in either moderate users or control subjects. They concluded that a higher degree of hearing loss is associated with long-term exposure to electromagnetic field generated by cellular phones.[10]

Panda *et al* found high frequency hearing loss in subjects using the mobile phones for more than 4 years.[30] Sahoo GC *et al* observed hearing loss in mobile

phone users and observed that severity of the deafness seemed directly correlated with duration of the mobile phone use.[31]

Meanwhile, in some other studies no significant effect was seen on hearing when the subjects were exposed to 10-min of EMF from a mobile.[11]Panda et al. found no significant differences between the mobile phone users and control for any of the audiological parameters.[23]Sivert *et al*, and Davidson and Lutman reported no effect of mobile phone use on audio-vestibular system.[32, 33]

In conclusion, with the excessive use of mobile phones in individuals, there has been raised concern regarding social and psychological effects. This study showed that the use of mobile phones predispose to hearing loss in the dominant ear. The unilateral increase in auditory threshold shift in the dominant ear in our study implies that the mobile phone is the cause. There appears to be correlation between the duration of daily use and the period of mobile phone use for years to the degree of hearing loss. Hearing loss and other health hazards resulting from the use of mobile phones are important factors that need further research, so more qualitative and quantitative studies in the future with larger sample sizes are suggested.

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