Effects Of Chronic Exposure To Mobile Phones Electromagnetic Fields On Inner Ear

S Bhagat, S Varshney, S Bist, S Mishra, V Jha, V Aggarwal

Citation

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Abstract

Introduction: The widespread use of mobile phones in recent years has given rise to concerns about the potential influences of its electromagnetic fields (EMFs) on human health. Anatomically, the ear is in close proximity to mobile phone during use. If there is subtle cochlear involvement, it might be detected by means of changes in otoacoustic emissions (OAEs). The aim of the present study is to investigate the effects of chronic exposure to EMFs emitting from mobile phones on inner ear using distortion product otoacoustic emissions (DPOAEs). Design and Setting: Cohort study and Tertiary care centre. Materials and Methods: Seventy five subjects were included in the study, who were chronic mobile users (using mobile phone for > 4 years), and using mobile phone only from one ear (mobile phone using ear). Subjects were further subdivided according to duration of mobile phone usage into two groups (group 1 usage < 60 minutes and group 2 usage > 60 minutes). All subjects underwent tympanometry and distortion product otoacoustic emissions (DPOAEs). The changes in DPOAEs were studied between mobile-phone using- ear (MPUE) and non-mobile phone using-ear (NMPUE) and between group 1 and group 2. Results: There is no statistically significant difference of having absent DPOAE in MPUE as compared to NMPUE (p value 0.38), and no statistically significant association was seen between group 1(talk time < 60 min) and group 2, (talk time > 60 min), in MPUE (p value 1.13) and NMPUE (p value 0.74). Conclusion: It was concluded that long-term and frequent exposure to EMFs from mobile phone does not cause damage to cochlea.

INTRODUCTION

In recent years there is tremendous increase in the usage of mobile phone worldwide, especially amongst young people. This widespread use of mobile phone has given rise to genuine concern regarding the potential influences of electromagnetic fields (EMFs) on human health. Mobile phones transmit and receive microwave radiations at frequencies mainly ranged between 800 and 2000 MHz, which excites rotation of water molecules and some organic molecules, causing thermal and non-thermal effects on humans [1]. The reported thermal effects from mobile phones include headache, sensation of burning or warmth of the ear, burning sensation in the facial skin and alteration in the blood-brain barrier [1,2,3]. Modification of sleep patterns, an increase in blood pressure and effects on cognitive function are the non-thermal effects described in literature [4,5,6].The potential carcinogenic effects of EMFs from mobile phones is controversial [7,8].

The auditory system is in the close proximity to the mobile phone so that hearing is potentially the most affected target of thermal and non-thermal effects. The external ear may provide a natural route by which EMFs from mobile phones may reach the peripheral and central auditory system, leading to relatively high energy deposition in the ear. Moreover, 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 and externally applied electric and magnetic fields are known to be able to produce some hearing sensation [9]. If EMFs from mobile phones causes subtle deleterious effects to the cochlea these can be detected by means of changes in the otoacoustic emissoin (OAE).

The present study was designed to investigate the possible effects of chronic and repeated exposure to EMFs from mobile phones on inner ear as measured by changes in distortion product otoacoustic emission (DPOAE).

MATERIALS AND METHODS

The study was conducted from January 2011 to January 2012, in the department of ENT, tertiary care centre, teaching hospital, Dehradun. Prior clearance for this study

was taken from institute's research and ethical committee. This was a prospective study which included 75 subjects (48 males and 27 females) with age range 18- 30 years who were chronic mobile users (taken as subject using mobile phone for more than 4 years). All subjects were medical students or nursing students with normal hearing. All subjects were informed about the aim of study before taking their consent.

Subjects with previous history of ear discharge, ototoxic medication, prolonged noise exposure, hearing loss, tinnitus, ear surgery and any systemic disease that would affect hearing were excluded from the study. Subjects using mobile phone in both ears were also excluded from the study. Detailed history of the patient was taken with regards to duration of mobile phone usage, history of hearing loss, tinnitus, vertigo and aural fullness, preferable side of mobile phone usage (mobile phone using ear). Otoscopic examination was performed before testing to rule out any external and middle ear pathology that could affect DPOAE measurements. Tympanometry was performed in all subjects to eliminate the possibility of middle ear problems.

All 75 subjects were further divided into two groups, according to daily use of mobile phone use as follows:

Group 1: subjects who are using mobile phone for less than 1 hour, for more than 4 years

Group 2: subjects who are using mobile phone for more than 1 hour, for more than 4 years

In group 1, there were 37 subjects, and in group 2 had 38 subjects were present.

All subjects who met the above criteria underwent DPOAE measurement. DPOAEs i.e 2f1-f2 cubic distortion product components were measured using the Neurosoft device (Neuroaudio). The frequency ratio of the two primary tones (f2/f1) was fixed at 1.22. DPOAEs were determined as response/growth or input/output aspect of DPOAE activity. The I/O functions were generated over a 60-db range of stimulus levels. These functions are acquired at 11 discrete test frequencies distributed in regular, ¼-octave intervals, from 1-8 kHz. From these curves, details concerning the function of a given ear's outer hair cells at either threshold related or suprathreshold sound levels can be determined. DPOAE was considered as absent when 3 consecutive frequencies fail to show the signal-to-noise ratio (SNR) greater than 6db.

DPOAEs were measured and compared between mobile phone-using ear (MPUE) and non- mobile phone-using ear (NMPUE) and between group 1 and group 2. The data obtained was subjected to appropriate statistical measure. Chi-square test was applied for comparison of observation between two groups.

RESULTS

In this study, 75 subjects were studied, (48 males, and 27 females). The mean age was 21.8 years. Out of 75 subjects, 60 were using mobile phone on right side (mobile- phone using ear), while 15 subjects were using on left side (mobile-phone using ear).

On analyzing the DPOAE, it was observed that, 16 out of 75 subjects 21.3% have abnormal DPOAE in MPUE and 13 out of 75 subjects 17.3% have abnormal DPOAE in NMPUE, and this difference is statistically insignificant (p value 0.385; Table 1).

Figure 1

Table1. Comparison of DPOAE between MPUE and NMPUE

DPOAE	Mobile phone-using ear (MPUE)	non-mobile phone-using ear (NMPUE)	Total	P value
PRESENT (NORMAL)	59	62	121	0.48
ABSENT (ABNORMAL)	16	13	29	
Total	75	75	150	

On analyzing the DPOAE with respect to duration of mobile use, no statistically significant association was seen between group 1(talk time < 60 min) and group 2, (talk time > 60 min), in MPUE (p value 1.13; Table 2) and NMPUE (p value 0.74; Table 3).

Figure 2

Table 2: Comparison of DPOAE between Group 1(60 min) in MPUE.

USAGE (DAILY PER MINUTES) IN MPUE	DPOAE PRESENT (NORMAL)	DPOAE ABSENT (ABNORMAL)	TOTAL	P VALUE
Group 1(<60 min)	31	06	37	1.139
Group 2 (<60 min)	28	10	38	
Total	59	16	75	

Figure 3

Table 3: Comparison of DPOAE between Group 1(60 min) in NMPUE.

USAGE (DAILY PER MINUTES) IN NMPUE	DPOAE PRESENT (NORMAL)	DPOAE ABSENT (ABNORMAL)	TOTAL	P value
Group 1(<60 min)	32	05	37	0.744
Group 2 (<60 min)	30	08	38	
Total	62	13	75	

DISCUSSION

With the rapid development of mobile telephony and increased personal usage of mobile phones, there is a widespread public concern regarding potential influences of EMF emitted by mobile phone. The exposure of users of mobile phones 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. [10].The inner ear is in the closest proximity to the mobile phone during use, leading to relatively high SAR deposition, as compared to the rest of the body.

Otoacoustic emission is often used in laboratories and clinics as a measure of inner ear health. OAE are low- intensity acoustic signals emitted by healthy cochlea in to the ear canal. They are associated with normal nonlinear active mechanisms in the cochlear outer hair cell. The OAE recordings are a sensitive and reliable method to assess in vivo cochlear functionality; their presence is an indicator of normal contractile outer hair cell activity. They are suitable for identifying subtle changes or effects of minor damage to outer hair cells [11]. Two commonly measured types of OAE are Distortion Product Otoacoustic Emission (DPOAE) and Transiently Evoked Otoacoustic Emission (TEOAE).

In the current study, we studied the effects of chronic mobile usage on hearing in healthy young adults using DPOAE measurement. DPOAE testing is quick, reliable and does not require active participants [12]. In animal models, DPOAE changes have been shown to precede morphological damage to the outer hair cells [13]. Minor changes in cochlear function which are undetectable by pure tone audiometry produce obvious DPOAE changes [12]. The high level of test-retest reliability of OAE testing enables the monitoring of dynamic cochlear responses [14].

Only limited research data concerning interaction between mobile phone exposure and the inner ear, using otoacoustic emission is available in the literature [15-18].

Ozturan et al. studied the effects of electromagnetic waves on the hearing of 30 volunteers. OAEs were compared before and after exposure to 10 minutes of cellular telephone use. No effect on the subject hearing was noted [16].

Uloziene et al. conducted a double- blind study to assess the effects of cellular telephone electromagnetic fields. The experimental and control group underwent PTA and TEOAE testing before and 10 minutes after cellular telephone use. No significant difference was observed between control and experimental groups [19].

Galloni et al. conducted a study in which rats were exposed to cellular telephone electromagnetic waves two hours a day, five days a week, for four weeks. No significant difference between DPOAE measurements was observed before and after exposure [20].

Kizilay et al. exposed adults and newborn rats to cellular telephone electromagnetic fields for 1 hour a day, for 30 days, and found no significant differences in pre- versus post-exposure DPOAEs [21].

Kayabasoglu et al. concluded that exposure to the EMFs emitted by cellular telephones, for 6 hours a day for 30 consecutive days, had no effect on the hearing of newborn or adult rats, at the outer ear, middle ear or cochlear level [22].

Most of the above mentioned studies were designed to investigate short term acute exposure to EMFs from mobile phone and the result obtained did not reveal any information regarding the potential effects of longer exposure or chronic cumulative exposure. Only few studies have been done to

investigate the effects of chronic exposure to EMFs from mobile phones on hearing [23-27].

In our study, it was observed that out of 75 subjects, (all using mobile phone for more than 4 years), DPOAE was absent in 16 subjects 21.3% in MPUE. This was in accordance with the observations made by Panda and colleagues,[25] who reported that maximum number of users with absent DPOAE (mobile-phone using ear) were in category C (users for > 4 years). However, these changes in the DPOAEs reported by Panda et al and in our study cannot be definitely linked with electromagnetic field exposure. On the contrary other studies did not report any changes in OAEs secondary to EMFs from mobile phones [16, 19, 20, 21].

On comparing the DPOAE between MPUE and NMPUE, abnormal DPOAEs were seen in (16 of 77, subjects i.e. 21.3%), in MPUE as compared to NMPUE (13 of 75, subjects i.e. 17.4%), and this difference is statistically not significant (p value 0.38). Kerekhanjanarong et al [23] and Panda et al [25] also did not find any significant difference in OAEs between mobile-using ear and non- mobile using ear.

On analyzing the DPOAE with respect to duration of mobile use, no statistically significant association was seen between group 1(talk time < 60 minutes/day) and group 2, (talk time > 60 minutes/day), in MPUE (p value 1.13) and NMPUE (p value 0.74). This was in accordance with the observation made by Panda et al [25], as they also did not find statistically significant difference in DPOAE among users with talk time (< 60 or > 60 minutes) however, the univariate odds ratio for abnormal DPOAE was 3.28 in favor of talk time > 60 minutes/day (95% CI 0.73-14.62, p value.13, not significant). On the contrary Kerekhanjanarong and colleagues [23] found that subjects who used mobile phones for 60 minutes/day had worse hearing thresholds in the dominant ear than in the nondominated ear. Oktay and Dasdag [24] also reported that those subjects who talked approximately 2 hours per day for 4 years were higher hearing loss than those in either moderate users or control subjects.

To analyze the data on average minutes of daily mobile phone usage may be a limiting factor in this study, as the duration of mobile phone usage is an oral history-based item. To get more precise picture call logs of all mobile phone users can be used, but this again is not possible in our study as the duration of phone usage is more than 4 years and with the advancement in technology many subjects prefer to change the mobile phone and mobile number frequently.

Our study is also not without limitations. Considering the number of mobile phone users worldwide, the sample size in the present study is small. We do not have a control population, which is difficult to obtain, because of technological advancement there is increased in accessibility and affordability to mobile phones. Other factors could also influence the results, which were not taken into consideration in our study, like type of mobile phone usage (GSM or CDMA), SAR value of mobile phone, strength of a signal, surrounding environmental noises, residing near the base station or TV tower. In our study, we have taken the criteria of DPOAE absent, when three consecutive frequencies failed to show signal-to-noise ratio (SNRs) greater than 6 db. Nevertheless, more numerical data with frequency- specific SNRs would have been more contributory.

CONCLUSION

This preliminary study suggests that prolonged and frequent exposure to EMFs from mobile phones usage do not cause damage to the inner ear or cochlea as measured by DPOAE. With the recent popularity of mobile phone use among the young people, and therefore potentially longer lifetime exposure, further studies with larger cohort are required to fill the gaps in the knowledge regarding harmful effects of EMFs from mobile phones on ear.

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Author Information

Sanjeev Bhagat, M.S. (ENT)
Dept. of ENT, Himalayan Institute of Medical Sciences

Saurabh Varshney, M.S (ENT)
Dept. of ENT, Himalayan Institute of Medical Sciences

Sampan Singh Bist, M.S (ENT)
Dept. of ENT, Himalayan Institute of Medical Sciences

Sarita Mishra, M.S (ENT)
Dept. of ENT, Himalayan Institute of Medical Sciences

Vivek Kumar Jha, (MSLAP)
Dept. of ENT, Himalayan Institute of Medical Sciences

Vinish Aggarwal, M.S (ENT)
Dept. of ENT, Himalayan Institute of Medical Sciences