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Effect of Electromagnetic Fields Emitted By Mobile Phone Onhearing Status in Healthy Human Beings

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ABSTRACT:
Wireless communication technology, such as mobile phones and internet, have advanced significantly in the recent decades. It is difficult to imagine life without these technologies. Exposure to radiofrequency electromagnetic field (RF-EMF) from mobile phones has been linked to a variety of negative health effects, including cold and flu-like symptoms, reduced sperm quality, memory and sleep problems, etc. Hearing loss is difficult to detect since it is slow and gradual, and user may not notice the change until it is advanced. A total of 300 healthy individuals of age group of 18- to 40-years after receiving informed permission, were divided into two groups: - Group A: which usages cell phone less than one hour per day. Group B: which usages cell phone more than one hour per day. Pure tone audiometry was conducted to evaluate and compare hearing threshold between exposed ears of both groups, exposed and non-exposed ears of same group and also between the same group at baseline and at 1-year follow-up. Hearing threshold for Air conduction at 250Hz, 500Hz, 1kHz, 2kHz, 4kHz and 8kHz were assessed while bone conduction thresholds were calculated at 500Hz, 1kHz, 2kHz, 4kHz. All the values of pure tone audiometry are statistically insignificant when compared with baseline and after one year.

Key Words: Electro-Magnetic Field, Global System of Mobile communication, High Frequency Hearing LossHeart Rate Variability, Noise induced hearing loss, Radio-Frequency Electro-Magnetic Field

I. INTRODUCTION

Life would be difficult without technology in today's contemporary day, and new research with enhanced technologies is generated on a regular basis. Wireless communication technology, such as cell phones and the internet, has advanced significantly in recent decades. Different sorts of communication services are expected to develop in the future, and it's hard to envisage a world without them.Because of mobile phone technology, studies on electromagnetic radiation began in India in the recent decade. Although mobile phone radiation is generally low, if the energy produced by the phone is absorbed by biological matter, it can have a negative impact on human health. [1]

Studies to evaluate potential of mobile phone radio frequencies in affecting human health in varied ways have been conducted in past. It is by the virtue of those studies that International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields as “possibly carcinogenic to humans”.[2]

Electromagnetic waves are used to transfer signals from mobile phones to mobile towers and vice versa.As the mobile phones are typically held close to the head while being used, one worry has been raised that the radio frequency waves generated during use may increase the risk of brain cancer. Studies have found increased risk of glioma but statistically significant difference was not noted.[2] RF-EMF systems have a higher risk of exposure than other types of RF systems. Most mobile phones include a tiny antenna since these antennas are so close to the user’s head, they produce more RF exposure than other types of RF systems.[3]

Hearing loss is difficult to detect since it is slow and gradual, and user may not notice the change until it is advanced. Comparison of hearing ability between the exposed and non-exposed ear has been studied by Prajapti et el, and hearing loss of higher severity was noted in exposed ear.[4] Due to gradual onset and slowly progressive nature of noise-induced hearing loss (NIHL) objective testing of hearing ability by pure tone audiometry is imperative. NIHL can be caused due to continuous exposure to noise levels above 85-90 decibels. Noise produced by mobile phone is usually a high-frequency one.[4,5] Not only that any exact mechanism for development of NIHL has not been described in literature but its causal association with mobile phone usage also needs to be validated due to varied reports with differing conclusions.

Mobile phones are single-channel, low-power two-way radios, whereas mobile towers are multi-channel, low-power two-way radios.

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Radiofrequency energies interact with biological matter in varied forms including microwaves, radio waves, radiofrequency radiation, and radio frequency emission. The concerned devices emit different forms as per their mechanism of action. Mobile phones across the globe function using different frequencies and the interaction between biological matter and these energies depend on a multitude of factors including source of these energies, frequencies, duration of exposure, and distance from source. The most commonly utilized frequency for mobile phones is 800-900 MHz.[6]

II. MATERIAL AND METHOD

Data collection

A cohort study was design to evaluate the effect that include the 300 normal subjects of Bikaner division. In this study samples were collected by Systemic random sampling technique. A total of 300 healthy individuals of age group of 18- to 40- years after receiving informed permission, those who met my inclusion and exclusion criteria were recruited in this study. Study participants were grouped in two groups:

Group A: which usages cell phone less than one hour per day.

Group B: which usages cell phone more than one hour per day

Subjects that refuseto sign a written, informed consent form and Known case of hypertension, pulmonary tuberculosis, chronic bronchitis or any other uncontrolled systemic or psychiatric disease, diabetes mellitus, asthma were excluded from the study.

Methodology:

Pure tone audiometry:[7,8]

Pure tone audiometry was conducted to evaluate and compare hearing threshold between exposed ears of both groups, exposed and non-exposed ears of same group and also between the same group at baseline and at 1-year follow-up.

Hearing threshold for Air conduction at 250Hz, 500Hz, 1kHz, 2kHz, 4kHz and 8kHz were assessed while bone conduction thresholds were calculated at 500Hz, 1kHz, 2kHz, 4kHz.

All the readings were noted and tabulated in the patient-detail sheet.

Statistical analysis

The observations and results wereanalysed using standard statistical procedures. Diverse factors were averaged across different groups of individuals.In order to compare the differences between the means, the student's paired 't' test was applied. In all cases, p values were calculated with two tails, and a value of less than 0.05 was judged to be statistically significant.

III. OBSERVATIONS TABLE AND RESULT

Table 1: Show the total no. of subjects (Male & Female)

This study comprised of participants divided into two groups. ‘Group A’ were the participants who used mobile phones less than 1-hour every day, had 123 males and 27 females. ‘Group B’ were the participants who used mobile phones more than 1-hour per day, had 120 males and 30 females.

Normal subjects	Group A	Group B
Male	123	120
Female	27	30
Total no.	150	150

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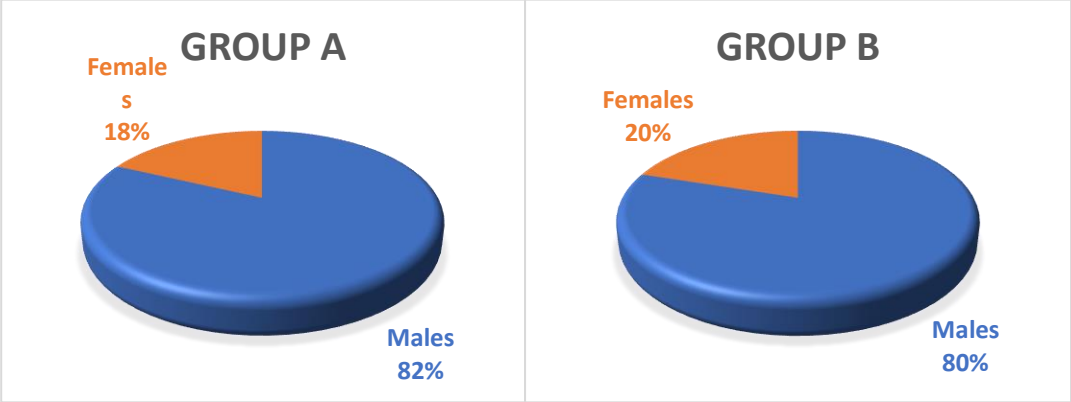

Figure 1 and 2: Demographic data of group A and group B, respectively.

Frequency	Group A	Group B	P Value
Air conduction threshold			
250Hz	14.46±6.10	14.26±3.72	0.73
500Hz	14.0±4.88	14.13±4.32	0.80
1kHz	13.23±6.95	13.5±3.78	0.61
2kHz	12.03±4.81	12.13±3.45	0.83
4kHz	12.86±4.75	12.6±4.00	0.59
8kHz	13.57±8.45	13.56±4.15	0.99
Bone conduction threshold			
500Hz	7.20±2.98	6.83±2.74	0.26
1kHz	9.70±4.26	9.33±3.41	0.41
2kHz	7.36±2.75	7.30±2.93	0.83
4kHz	7.13±2.85	7.20±2.92	0.84

Table 2 shows the comparison on pure tone audiometry of exposed ear of study participants of group A versus group B at baseline. Values on different frequencies were statistically insignificant both in air conduction and bone conduction threshold.

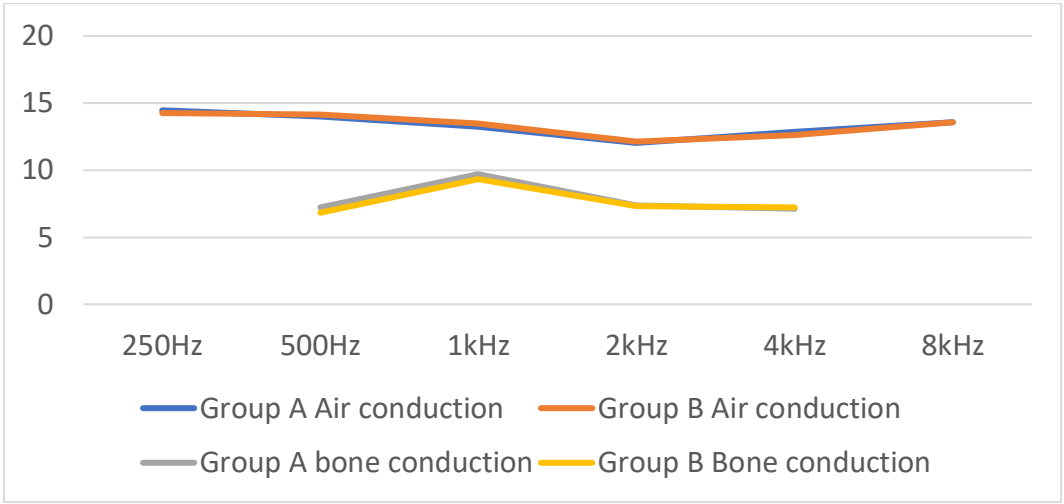

Figure 3: Comparison on pure tone audiometry of exposed ear of study participants of group A versus group B at baseline.

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Frequency	Group A	Group B	P Value
Air conduction threshold			
250Hz	14.40±5.04	14.16±3.34	0.63
500Hz	14.03±4.12	14.10±3.38	0.87
1kHz	13.12±6.06	13.16±3.81	0.93
2kHz	12.06±3.57	12.16±3.94	0.81
4kHz	12.76±3.50	12.86±3.67	0.80
8kHz	13.53±4.19	13.56±3.76	0.95
Bone conduction threshold			
500Hz	7.50±3.78	6.93±2.76	0.14
1kHz	9.16±4.42	9.56±4.13	0.41
2kHz	7.26±3.09	7.20±2.86	0.84
4kHz	7.18±2.97	7.26±3.04	0.80

The same examination method was used for conducting PTA of non-exposed ears as well and results were tabulated as presented in **Table 3**. All the Values on different frequencies were statistically insignificant both in air conduction and bone conduction threshold.

Frequency	Group A at 1-year follow-up	Group B at 1-year follow-up	P Value
Air conduction threshold			
250Hz	14.43±4.31	14.43±4.61	1
500Hz	14.06±5.59	14.06±4.61	1
1kHz	13.16±5.91	13.20±5.15	0.95
2kHz	12.03±5.67	12.04±4.48	0.99
4kHz	12.86±3.81	12.83±4.11	0.93
8kHz	13.56±3.94	13.58±4.67	0.97
Bone conduction threshold			
500Hz	6.96±2.71	7.03±2.72	0.82
1kHz	9.46±3.93	9.63±4.01	0.71
2kHz	7.13±3.08	7.20±3.14	0.85
4kHz	7.30±2.69	7.00±2.65	0.28

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Table 4 shows the Comparison on pure tone audiometry of exposed ear of study participants of group A versus group B at 1-year follow-up. All the Values on different frequencies were statistically insignificant both in air conduction and bone conduction threshold.

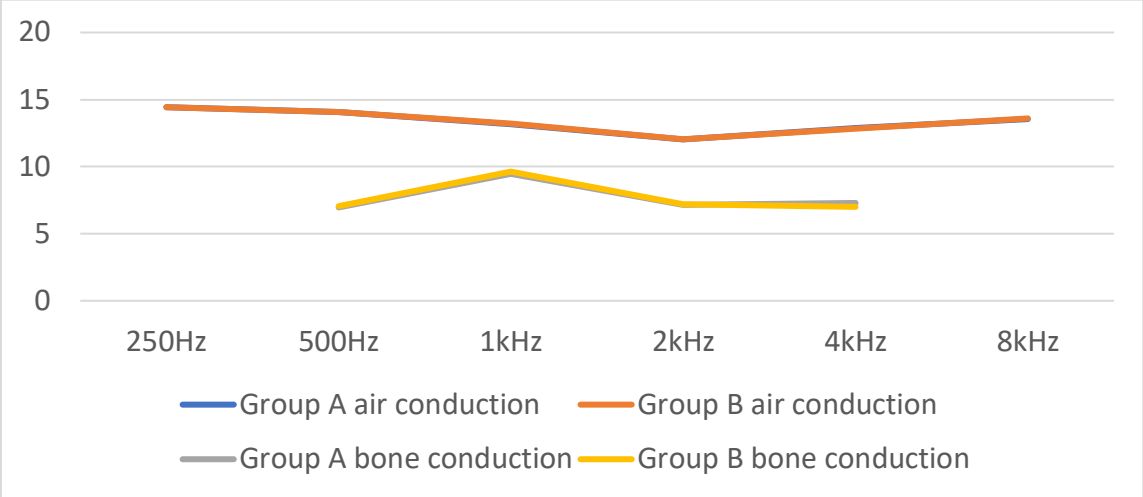

Figure 4: Comparison on pure tone audiometry of exposed ear of study participants of group A versus group B at 1-year follow-up.

Frequency	Group A at 1-year follow-up	Group B at 1-year follow-up	P Value
Air conduction threshold			
250Hz	14.53±4.38	14.46±4.92	0.90
500Hz	14.13±4.55	14.06±4.38	0.89
1kHz	13.10±6.20	13.10±4.54	1
2kHz	12.1±4.53	12.03±3.71	0.89
4kHz	12.90±3.98	12.83±4.68	0.89
8kHz	13.60±4.10	13.60±4.52	1
Bone conduction threshold			
500Hz	7.13±2.61	7.03±2.90	0.75
1kHz	9.30±3.93	9.46±3.89	0.70
2kHz	7.16±3.03	7.36±2.93	0.55
4kHz	7.31±3.14	7.33±3.04	0.94

Table 5 shows the comparison on pure tone audiometry of non-exposed ear of study participants of group A versus group B at 1-year follow-up. All the Values on different frequencies were statistically insignificant both in air conduction and bone conduction threshold.

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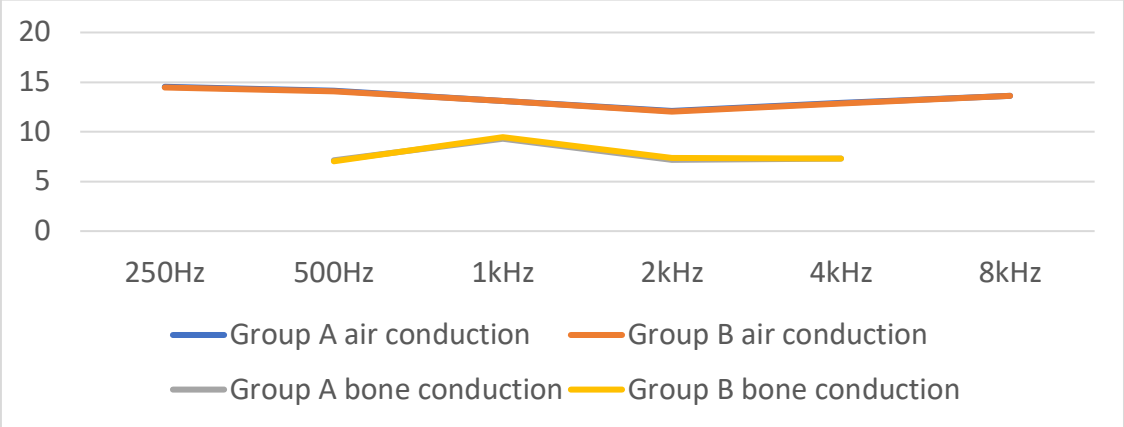

Figure 5: Comparison on pure tone audiometry of non-exposed ear of study participants of group A versus group B at 1-year follow-up.

IV. DISCUSSION

The present study was designed to test the hearing thresholds on pure tone audiometry among healthy individuals who were using mobile phones for different duration every day in the department of physiology, S.P. Medical College, Bikaner.We divided the study participants in two groups, group A were the participants who were using the mobile phone for less than an hour every day while group B were the participants who were using the mobile phone for more than an hour every day.

The assessment of hearing thresholds was done using the pure tone audiometry. The PTA was done for assessment of both the air conduction and bone conduction according to "American speech-language-hearing association" guidelines.[9] The hearing thresholds were noted at different frequencies and average pure tone thresholds were noted by calculating average of hearing thresholds at various frequencies. The predominance of one ear over the other while using the mobile phones or higher propensity of one ear getting more exposure as compared to the other was noted by Seidman et al. in their study.[10]In our study, we asked the individuals about their preferred ear and termed it 'exposed ear', the other ear was termed 'non-exposed ear'. The individuals who couldn't be certain of their preferred ear were not included in the study. A limit of 1-hour was taken as the deciding criteria as to which group the participant belonged to.

Ramya et al.[11] in their study, noted a significant raise in the hearing threshold associated with higher duration of usage of mobile phones. But contrary conclusions too have been reported in the literature. Oktay et al.[12] studied hearing threshold in mobile phone users who were using mobile phones for different durations. In their study, it was noted that participants who were using mobile phones for 10-20min/day had no significant disturbance in hearing threshold but the thresholds were significantly higher in the participants who were using mobile phone for more than 2-hours/day. Prajapti et al.[4] studied effect of chronic use of mobile phones on hearing thresholds in young adults, and found that individuals who were using mobile phones for a higher duration had a higher hearing threshold. Study by Velayutham et al. suggested role of probable inner ear damage due to mobile phone usage.[13] Most of the studies which noted a higher threshold associated with mobile phone usage studied exposure for a longer duration.

In our study, no significant difference between exposed and non-exposed ears of group A and group B was noted at the baseline examination, making both the groups comparable. Analysis of the pure tone audiometry data was done also to assess if there was a significant difference between the hearing thresholds of exposed and non-exposed ears of the participants of same group at different frequencies during the baseline examination but no significant difference was noted during this comparison.

The pure tone audiometry was repeated for all study participants at 1-year follow-up and the results were tabulated. A comparison between group A and group B at 1-year follow-up showed no significant difference between the hearing thresholds in both air conduction and bone conduction. A similarly tabulated data putting exposed ears against non-exposed ear of the same groups showed a higher bone conduction threshold at 1kHz frequency in both group A and group B, but the difference was not statistically significant.

Another comparison between baseline and 1-year follow-up PTA results of the same groups was also conducted, both the sets of data were

comparable and no significant difference was noted.

A European multicentric study titled GUARD was conducted in 9 centres to evaluated changes in hearing ability due to exposure to low-intensity EMF produced by mobile phones working on global system for mobile communications (GSM) technology.[14] It involved evaluation of hearing thresholds both before and after the exposure to RF-EMF produced by mobile phones. It was a double-blind design, including an actual RF-EMF exposure and a sham exposure. It showed no significant effect on the status or functioning of auditory system.[14]

V. CONCLUSION

With growing usage of mobile phones in daily life it becomes imperative to ascertain the effects of mobile phone's RF-EMF exposure on healthy human beings.The current study revealed that Hearing thresholds tested by pure tone audiometry by both air conduction and bone conduction showed that there was no statically significant difference between the groups who used mobile phones for less than an hour every day and those who used mobile phone for more than an hour every day.

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