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A Comparative study on brainstem auditory evoked potentials in short term and long-term mobile phone users

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Abstract

The use of mobile phones has increased significantly in India. The mobile phone is seen as a crucial instrument for communication and has permeated every aspect of society. Due to the increasing usage of mobile phones, concerns have been raised about the potential negative health consequences of high-frequency electromagnetic fields (emfs) on hearing function.

Objective: To assess and compare the effect of smartphones on short-term and long-term mobile phone users on Brainstem Evoked Response Auditory (BERA).

Materials and Methods: A cross-sectional study was carried out on a total of 30 healthy subjects aged 18-60 years of both genders. Subjects were divided into short-term mobile phone users who used mobile phones for ≤ 5 years and long-term mobile phone users who used mobile phones for> 5 years.

Results: There was no significant difference was seen in latencies and interpeak latencies of ABR waves of short- and long-term mobile phone users.

Keywords: Brainstem Evoked Response Audiometry, Auditory Brainstem Response, Mobile Phone, Electromagnetic Waves.

Introduction

The auditory system may be affected by mobile phone waves because the temporal lobes and cochlear nerves are anatomically close to mobile phone's emitted waves and they have great exposure to EMW (electromagnetic waves) emitted by mobile phones.[9] The ear is most susceptible to high SAR deposits because it is the one

closest to the mobile phone. Mobile phones are in a perfect position to disrupt the auditory system as using them close to the ear raises the SAR (specific absorption rate) of the waves. SAR is a measurement of the rate at which RF (radio frequency) exposure from a cell phone is absorbed by the body.[13]

Brainstem Evoked Audiometry Response (BERA) is a quick, and non-invasive approach for determining the functional status of the auditory nerve and brainstem auditory sensory pathway.[13] The first documented report of humans employing surface electrodes to capture cochlear potentials was published in 1967 by Sohmer and Feinmesser. The latter waves were believed to have been produced at the level of the brain stem until Jewett and Williston presented a precise description of these waves in 1971.[14]

BERA is a widely utilized objective diagnostic tool in contemporary neurophysiology. The auditory brainstem's neural conduction velocity is successively reflected by several waves in the electrical responses from BERA at different levels.[15]

The term "auditory evoked potentials" (aeps) refers to any electrical potentials produced by auditory stimuli externally presented in any area of the auditory system, from the cochlea to the cerebral cortex. The auditory nervous system is activated by sound, and this activation can be seen as a change in neuroelectrical energy in the auditory nerve, the auditory centers of the lower part of the brain (brainstem), as well as from higher up in the auditory pathways, at the midbrain, thalamus, and cortex.[16]

Lohitashwa R et al did a study to evaluate the effects of mobile phone exposure on Brainstem Evoked Response Audiometry (BERA) and their results showed significantly increased latencies of wave III and wave V and also significantly increased interpeak latency of wave I-V in group 1(long-term mobile phone users).[15] Ebrahim MA et al evaluate the effects on the auditory function of chronic exposure to electromagnetic fields from mobile phones and the results did not reveal any statistically significant differences between the control ear (non-phone-using ear) and the one that used the phone .[17] Mishra S et al evaluate the impact of long-term exposure to a mobile phone's electromagnetic field on the auditory function and the wave I-III, wave III-V, and wave I-V interpeak latencies between the ear that was using a phone and the control ear did not significantly differ from one another, and there was also no variation in these latencies based on how long the user had been using the phone.[7]

Analyzing this study will help the general public become more aware of the negative consequences of electromagnetic radiation and loud noise, both of which are created by mobile phones.

Materials and methods

This study was conducted in the Department of Physiology in collaboration with the Department of ENT, Moti Lal Nehru Medical College, and SRN Hospital Prayagraj over a period of one year. The institution's ethical committee gave its approval to this study. Individuals aged 18-60 years of both genders were recruited for the study. The study sample comprises 30 individuals who were randomly allocated based on their criteria for fulfilling eligibility criteria. Subjects were divided into two groups – 15 subjects were long-term users (>5 years) and 15 were short-term (1-5 years). Mobile phone users.

Eligibility Criteria

Inclusion criteria

- Healthy individuals with intact tympanic membrane.

- Subjects of age 18-60 years.
- Subjects with no history of any ear ailment or deafness in the past or present.
- Subjects who use mobile phones for 1 year or more than one year.
- Subjects who had given written consent for the participation in the study.

Exclusion criteria

- Presence of ontological illnesses in the population, such as ear discharge, inability to hear, and ear surgery.
- Prolonged loud noise exposure.
- Using an ototoxic medication and suffering a brain injury.
- Personal or family history of hereditary hearing impairment or deafness.
- Any systemic illness such as diabetes, hypertension, and brain damage which could result in hearing loss.
- Subjects unwilling to participate in the study.

Complete ENT examination including Rinne's test and Weber's test was done in all patients before BERA. To reduce the artifacts, the individuals were instructed to lie down on the bed and made to completely unwind. Hair clips and earrings were taken off because they might affect the recordings. All participant's consent under the inclusion criteria was taken and BERA was conducted on them. BERA was performed by GSI Audrea BERA Machine in ENT.

Department and the standard procedure carried out is stated as follows:

• On the test bed, the participants were positioned supine.

• Electrodes have been implanted over the patient's head. The preferable surface electrodes are those that are filled with conducting jelly or paste.

• An inverting (active) electrode was placed over the mastoid prominence, an inverted (reference) electrode was placed over the vertex of the head, and a ground electrode was put over the top of the forehead.

•A transducer installed in the insert earphone transmits stimulation to the ear in the form of a click.

• Monoaural recordings are made by stimulating the ear under study with 90 db of stimulation. To ensure a correct reaction, the contralateral ear is always muffled with white noise at a level 40 db lower than the ipsilateral click stimulation.

Data analysis

SPSS version 21.0 was used for statistical analysis. Data were presented as mean (standard deviation) and percentage (%). The independent t-test was used to compare discrete variables between groups. The p-value of <0.05 was considered significant.

Results

Table 1: Demographic Profile

	Mean ± SD
Age (years)	39.43 ± 15.21
Body weight (kg)	73.23 ± 11.43
Height (feet)	5.56 ± 0.30
BMI (kg/m2)	25.36 ± 3.64

Table. 1 show the mean age (yrs.) Of 39.43±15.21, the mean body weight (kg) is 73.23±11.43, the mean height (feet)is 5.56±0.30 and the mean BMI (kg/m^2) is 25.36±3.64

Table 2: Comparison of frequencies of gender Educational status

	(n=30)	
	n	%
Gender		
Male	20	66.67

Female	10	33.33
Education		
High School	3	10.00
Intermediate/Diploma	5	16.67
Graduate	17	56.67
Professional Degree	5	16.67

Table. 2 The frequencies of the male and female sex are 66.67% and 33.33% respectively, and the Educational level of all the subjects is no less than high school.

		BERA Group (n=30)	
		n	%
Rinnie's test	Positive	30	100.00
	Negative	0	0.00
Weber's test	Positive	0	0.00
	Negative	30	100.00

Table 3 The table shows all subjects had an intact tympanic membrane with a positive Rennie test and negative Weber test.

Table 3: Comparison of hearing tests (Rennie's, Weber's test)

Table 4: Comparison of inter wave latency of short-term and long-term mobile uses on BERA.

Inter Wave Latency	Waves	Ear	Short term (n=15)	Long term (n=15)	t	P-Value
			Mean ± SD	Mean ± SD		
Interwave latency @ 90 dB	Wave I	Left	1.25±0.16	1.28±0.23	-0.475	0.638
		Right	1.44±0.20	1.42±0.21	0.274	0.786
	Wave III	Left	3.57±0.27	3.58±0.30	-0.107	0.915
		Right	3.83±0.25	3.78±0.21	0.638	0.528
	Wave V	Left	5.17±0.08	5.23±0.21	-0.986	0.333
		Right	5.24±0.11	5.34±0.21	-1.700	0.100
Interwave latency @ 80 dB	Wave I	Left	1.35±0.16	1.35±0.20	0.010	0.992
		Right	1.54±0.17	1.53±0.25	0.176	0.862
	Wave III	Left	3.66±0.21	3.65±0.21	0.137	0.892
		Right	3.82±0.13	3.82±0.15	-0.013	0.990
	Wave V	Left	5.56±0.18	5.68±0.40	-0.998	0.327
		Right	5.51±0.16	5.55±0.19	-0.606	0.549
Interwave latency @ 70 dB	Wave I	Left	1.72±0.15	1.65±0.23	0.921	0.365
		Right	1.71±0.20	1.68±0.17	0.383	0.705
	Wave III	Left	3.67±0.15	3.77±0.17	-1.661	0.108
		Right	3.82±0.17	3.75±0.29	0.888	0.382
	Wave V	Left	5.80±0.28	5.83±0.27	-0.259	0.798
		Right	5.82±0.27	5.75±0.22	0.735	0.469
Interwave latency @ 50 dB	Wave V	Left	6.31±0.45	6.24±0.35	0.475	0.638

		Right	6.23±0.41	6.26±0.43	-0.201	0.842
Interwave latency @ 30 dB	Wave V	Left	6.61±0.36	6.74±0.34	-1.021	0.316
		Right	6.97±0.22	7.02±0.27	-0.494	0.625

Table 4 The table shows that wave I, wave III, and wave V Inter wave latency of BERA was not significantly ($p<0.05$) different in short-term and long-term mobile use.

Table 5: Comparison of interpeak latency of short-term and long-term mobile uses on BERA

Interpeak Latency	Waves	Ear	Short term (n=15)	Long term (n=15)	t	p-Value
			Mean ±SD	Mean ±SD		
IPL @90dB	wave I-V	Left	3.82±0.12	3.78±0.14	0.830	0.414
		Right	3.83±0.10	3.82±0.10	0.250	0.804
IPL @80dB	wave I-V	Left	3.81±0.08	3.83±0.13	-0.498	0.622
		Right	3.79±0.13	3.84±0.07	-1.229	0.229
IPL @70dB	wave I-V	Left	3.84±0.15	3.81±0.26	0.420	0.677
		Right	3.89±0.09	3.92±0.07	-0.796	0.433

Table 5 The table shows the Inter peak latency of BERA was not significantly ($p<0.05$) different in short-term and long-term mobile use.

Discussion

The use of cell phones is gaining acceptance and has practically become a necessity in today's life. This is one of the technological achievements with the fastest growth rate in modern times. However, there is growing public concern about possible health hazards from electromagnetic fields (EMF) to which cell phones are exposed. Cell phone antennas emit high-frequency electromagnetic radiation. These can be absorbed and converted into heat when they penetrate organic tissue. A significant amount of EMF energy can be deposited in the ear when the antenna of a cell phone is near the user's ear despite the fact that there is a lot of worry about the security of mobile devices and their ground stations., few studies have been published specifically on these emissions. This may be because cell phones have only recently been used by the general public, leaving little time to identify all of the health effects. Communities are not genetically uniform, and people's susceptibilities to environmental dangers like EMF from cell phones might vary 3,18

In our study, we aim to evaluate and compare the effects of smartphones in short-term and long-term cell phone users on ABR. For this purpose, a total of 30 patients were enrolled in this cross-sectional observational study. In this study, the educational level of the patients was at least high school. In our study, the mean body weight was 73.23±11.43 kg. The frequencies of the male and female sex were 66.67% and 33.33% respectively. In this study, the educational level of the patients was at least high school. In our study, the mean body weight was 73.23±11.43 kg. The mean height was 5.56±0.30 feet in our study. In this study, the mean BMI was 25.36±3.64 kg/m2. In this study, of the 30 patients, all had an intact tympanic membrane, a positive Rennie's test, and found no sound lateralization in any ear in the Weber test. In our study, the percentage of short-term

(≤5 years) and long-term (≤5 years) cell phone use was 50.00% and 50.00%.

In our study, the wave I, wave III, and wave V Interwave latency of BERA was not significantly different in short-term and long-term mobile use. The latencies, interpeak latencies, and amplitudes of these auditory-evoked brainstem responses are not significantly affected by the electromagnetic field.3 Regarding the interaction of microwaves with cell membranes, has presented encouraging results.19,20 In their study with 60 participants, they found no significant differences in the parameters of ABR between non-users and moderate users (maximum 30 minutes per day for 5 years).20 Chronic users (who used a cell phone for a maximum of 30 minutes per day for at least 10 years) had a significantly longer delay in waves I and II than short-term users (who used a cell phone for no more than 15 minutes per day).21

Conclusion

It was determined that, in terms of brainstem auditory evoked responses (ABR), prolonged usage of cell phones does not negatively impact the hearing system in some way.

Mobile phones should only be used for immediate needs and for brief periods of time. The consequences of mobile phones on each person's health can differ because the population is genetically diverse. Therefore, we recommend using cell phones carefully. Although the current study found no evidence of an impairment in auditory conduction associated with the use of mobile phones, additional research with more participants and longer exposure times is necessary to confirm this finding.

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