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Original Research Article

Effect of Electromagnetic Radiations of Smart Phones on Hearing by Brainstem Evoked Response Audiometry

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Abstract

Background: Electromagnetic radiations from smart phones alter and prolongs the conduction in auditory tract.

Materials and Methods: Age between 18-30 years**,** Group 1, N=50 people had electromagnetic radiations exposure for 1-5 years and exposed more than 3 hours per day. Group 2, N=50 people had electromagnetic radiations exposure for greater than 5 years and exposed more than 3 hours per day. Headache, tinnitus, anti-psychotic, anti-depressant drugs, smokers were excluded. Brainstem evoked response audiometry (BERA) was done. Online GraphPad calculator using Student unpaired t test data was analysed. It was a case control study.

Results: BERA parameters like waves III, V, interpeak latencies at 90 dB and 2 KHz in Group 2 were prolonged in comparison to Group 1.

Conclusion: Brain stem evoked response audiometry (BERA) records subclinical hearing loss in smart phone users at 2 KHz and 90dB.

Keywords: Brainstem Evoked Response Audiometry (BERA), Electromagnetic Radiations.

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Introduction

Prolonged exposure of electromagnetic radiations cause decline in cognition, headache, disturbance in sleep cycle and localized thermal effects in surrounding areas of ear.[1] Hence electromagnetic radiations possess the potential to cause subclinical damage to the auditory conduction pathway. [2]

BERA is an effective noninvasive diagnostic test. By utilizing click stimuli delivered via headphone, BERA captures electrical potentials from the brainstem through the surface electrodes positioned on the mastoid and scalp vertex.[3] Compared to other tests for brainstem assessment BERA provides streamlined approach for the early detection of central neuropathy. [4] BERA records the seven distinct BERA waves labeled I through VII within 10-millisecond [5] Limited literature on research of effect of electromagnetic radiations of smart phone on ears by BERA is available. Hence, effect of electromagnetic radiation on auditory conduction pathway is studied by BERA.

Aim: To assess the effect of electromagnetic radiations on auditory system by BERA at 2 KHz frequency and 90 dB intensity.

Material and Methods

Following ethical approval and the acquisition of written informed consent, a case control study was conducted. The research took place between Oct 2022 and Aug 2023 within the Dept of Physiology at IGIMS, Patna

Inclusion Criteria: This study included 100 subjects aged 18–30 years. In Group 1, 50 subjects exposed to electromagnetic radiations for greater than three hours per day for a duration of 1-5 years. Group 2 had 50 subjects, exposed to electromagnetic radiations for greater than three hours per day for more than 5 years were enrolled. The primary hypothesis was that the latency and interpeak intervals of BERA waves would be delayed in adults exposed to electromagnetic radiations for prolonged duration. Sample size calculated with AI - therapy statistics BETA. With an effect size of 0.8, an alpha of 0.05,[6] and a power of 80% for a one tailed hypothesis,[7] a total of 100 subjects was required. (50 per group).

Exclusion Criteria: Systemic diseases like Diabetes mellitus, neuropathy, and hypertension.

Lifestyle factors like smoking or tobacco consumption. Otological issues like tinnitus, burning sensations around ear, traumatic ear disorder, family history of hearing disorder, noise induced hearing loss. Medication like those on anti-depressant, anti-psychotic drugs, drug abuse, furosemide drug and others like covid positive subjects, arrhythmia were excluded.

Rennie's and webbers tests were performed to assess hearing loss. Body mass index as weight in kilogram divided by height in meters square (kg/m2) was calculated.[8]

Procedure: Brief click acoustic stimuli by headphone on right ear at 90 dB and 2 KHz frequencies were given.[4] Impedance was less than 5 kohm and filter between 100 Hz to 3000 Hz was set.[5] 2000 sweeps.

Active electrode at the mastoid, reference at vertex of skull and ground was placed at the forehead. The dominant ear was tested first and contralateral ear masking was done with white noise 40 dB. At least 2 readings were recorded. BERA waves and interpeak latency were recorded.

Statistical Analysis: GRAPHPAD QUICKCALCS online student unpaired t-test was used for data analysis. BERA parameters comparison was done between Group 1 and Group 2. The statistical significance was at p value < 0.05.

Result

BERA waves were recorded between Group 1 and Group 2 candidates. Mean data of Group 1 at 90 dB, 2 KHz of waves I was 1.59 ± 0.19 , wave III was 3.51 ± 0.14, wave V was 5.42 ± 0.16 and inter-peak latencies wave I-III was 1.77 ± 0.22, wave III-V was 1.92 ± 0.22 , wave I-V was 3.77 ± 0.33 and Group 2 of wave I was 1.61 ± 0.20, wave III was 3.64 ± 0.14, wave V was 5.59 ± 0.30, interpeak latency wave I-III 1.99 ± 0.25, wave III-V was 2.03 ± 0.17, wave I-V was 3.97 ± 0.40(ms) respectively. Wave I was not significant (p-value>0.05). Group 2 values were statistical significant (p-value<0.05). [Table-2].

Table 1: Demographic Data

Parameters	Group 1 (n=50)	Group 2 (n=50)
Age (Years)	21.21 (3.2)	20.57(1.7)
Weight(Kg)	50.13 (1.61)	50.17 (1.86)
Height (cm)	155.86 (1.89)	156.71 (1.23)
BMI	20.86(3.03)	20.61 (2.13)

Table 2: BERA parameters at 90 dB and 2 KHz between Group 1 mobile phone users between 1-5 years and Group 2 mobile phone users more than 5 years

Waves	Group 1(n=50) Mean ± Standard Deviation (msec)	Group 2(n=50) Mean ± Standard Deviation(msec)	P Value
I	1.59 ± 0.19	1.61 ± 0.20	0.85(NS)
III	3.51 ± 0.14	3.64 ± 0.14	0.03 (S)
V	5.42 ± 0.16	5.59 ± 0.30	0.04 (S)
Interpeak Latency I-III	1.77± 0.22	1.99 ± 0.25	0.01(S)
III-V	1.92 ± 0.22	2.03 ± 0.17	0.03(S)
I-V	3.77 ± 0.33	3.97 ± 0.40	0.03(S)

p < 0.05 – Statistically Significant. p < 0.001 – Statistically Highly Significant.

Discussion

This study evaluated BERA waves and interpeak latency I-III, III-V and I-V between group I (n = 50) and group II (n = 50) on right ear. Wave III and wave V in Group 2 people were prolonged in comparison to Group 1. Hence, electromagnetic radiations damaging auditory pathway were reported.

At 2 KHz and 90 dB, a significant delay (P <0.05) in absolute latencies of wave III, wave V and interpeak latencies I-III, III-V, I-V in group 2 as compared to group 1. This is supported by Jha et al [8], Kothari et al [9], Khullar S et al [10] and Kellenyi L et al [11] studies. Kaprana AE et al reported delayed wave III and interpeak latencies of I-V and III-V during mobile phone radiations in rabbits.[12] Philip et al study by otoacoustic emission test supported above findings in smart phone users due to damage of cochlear hair cells. Oktay et al [13] and Bhagat S et al [14] did not support the above findings.

Conclusion: BERA recordings at 2 KHz and 90 dB, central neuropathy may be recorded earlier in electromagnetic radiations exposed smart phone users.

Implication of the study: Minimum usage of mobile phones will definitely reduce the deleterious effect of radiations. Usage of speakers will definitely help in reducing the hazardous effect of radiations.

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