(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 5, Issue 3, Page No: 1415-1421
May-June 2022

IJMSCR

Assessment Of Auditory Brainstem Response And Hearing Threshold Among Frequent Mobile Phone Users Of The Adolescent Population- A Cross-Sectional Analytical Study

[1]Dr. M Gopinath, [2]Dr. Lakshmi Jatiya, [3]Mr. John Wesley
[1]Associate Professor, [2]Professor & HOD, [3]Assistant Professor,
Department Of Physiology, Aarupadai Veedu Medical College & Hospital,
Kirumampakkam, Puducherry- 607402

***Corresponding Author:**
Dr. M Gopinath
Associate Professor, Department Of Physiology, Aarupadai Veedu Medical College & Hospital,
Kirumampakkam, Puducherry- 607402

Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

The mobile phone is the nectar that evolved as a result of the Information technology revolution, but as with the churning of the ocean, along with nectar the poison evolved is its overuse and exposure to electromagnetic frequencies (EMF). A cell phone emits an EMF of range 900 to 1800 MHz, which has been the focus of debate for decades. Excess mobile phone users are at a higher risk of road traffic accidents, leukemias, and brain tumors as most of the radiation passes directly onto the head of the individual. The evoked potential recordings are designed to test the three most important of the five senses, sight, hearing, and touch. Measurement of evoked potential is an objective and non-invasive method of testing the function of the nervous system. BAEPs provide a sensitive means for the assessment of the brainstem auditory tract and nearby structures.

Aim: To assess the impact of frequent mobile phone usage on hearing dysfunction and to measure the level of dysfunction.

Methods: this Cross-sectional analytical study was conducted over 1 year at Aarupadai Veedu Medical College & Hospital, Pondicherry. Collaborative departments in the study were physiology & school of audiology .100 cases (frequent mobile phone users) from the second year to final year are screened for their cell phone usage patterns and those who have been using mobile phones for 5 years or more will be considered as cases. Group a-50 cases use of cell phone <5 years, group -b 50 cases use of cell phone >5 years. The following tests will be performed on the subjects recruited for the study as per our inclusion criteria:

Results: The mean height in group-A was 156.34 ± 8.47, and it was 156.72 ±10.08 in Group -b. The mean weight in group -a 56.46 ± 9.78, it was 58.48±10.54 in Group B. The mean BMI in group -A was 23.11±3.63, and it was 23.9 ± 4.29 in Group -b. The difference in anthropometric parameters between the two groups was statistically not significant. (P-value >0.05). Among group -a 7 (14%) had normal PTA, and 43 (86%) had abnormal.PTA. Among group -b 32 (64%) had normal PTA and 18 (36%) had abnormal PTA. The difference in the proportion of PTA between the two groups was statistically significant. (P-value <0.001). There was no statistically significant difference in BERA latency between group -a & group -b, P-value of 0.341(>0.05). There was a statistically significant increase in the absolute latency of waves II, IV, V, and interpeak latency waves I- V, III- V in the left ear. There was no statistically significant difference in BERA left ear latencies I, III, I - III between group -a & group b (P-value >0.05). There was a statistically significant increase in the absolute latency of waves II, IV, V, and interpeak latency waves I- V, III- V in the right ear compared. There was no statistically significant difference in BERA left ear latencies I, III, I - III between-group -a & group b (P-value >0.05). Among people with normal BERA wave latency, there was no statistically significant

difference in right and left ears between the two groups with a P-value of 0.095. Among people with normal BERA wave latency, there was no statistically significant difference in males and females between the two groups with a P-value of 0.393. Among people with abnormal BERA wave latency, there was no statistically significant difference in males and females between the two groups with a P-value of 0. 668.

Conclusion: In our opinion, the pathological dependence on mobile also fulfills the criteria of so-called "Mobile or Cell Dependence Syndrome" resembling substance Dependence Disorder, producing predominantly 'Psychological Dependence'. Mobile phone use can be considered as one of the socialized forms of addiction or dependence. But further studies are necessary to evaluate the sensitivity and specificity of the BERA testing. If changes in the organ of Corti detected before DO by a noninvasive diagnostic procedure like BERA will help degree of serious complications that may cause hearing loss.

Keywords: Sensorineural Hearing Loss, Distortion Product Otoacoustic Emission, Pure Tone Audiometry Auditory Brainstem Response, High-Frequency Audiometry

Introduction

This is an era of information technology, an era of communication devices, the most common being cell/ mobile phones. Cell phones have become an indispensable accessory nowadays. This small and relatively inexpensive device holds an important place in the day to day life. Cell phones have many functions which include calls, SMS (short messaging system), emails, internet access, music, storage of files, banking, etc, which has made life more dependable on cell phones. Cell phones have made life very easy and approachable. Our country, India, has 919.17 million cell phone users [1]. Currently, India has the second-largest number of cell phone users after China [2] There have been several scientific reports concerning the possible relationship between exposure to radiofrequency fields (RF) during mobile phone use and reported harmful effects. to regular cell phone usage such as Headaches, Dizziness, Nausea, Memory loss, Mood swings (rage), Sleep, disorders, Fatigue, Loss of concentration, lack of coordination, Pain in hands or arms, and Skin sensations. Hocking reported Disturbing symptoms from the use of mobile telephones [3]. He reported some patient accounts in his paper as- 1. 'It has been noted that by using the mobile phone in the transmit mode, the side of the head closest to the phone heats up and at different periods persistent migraines appear.'2. 'I have noticed persistent strong headaches for a period of 4 days; worsening after using the mobile phone for extended periods (approx. 10-15 minutes, 4-5 times a day). These headaches have been occurring on the left side of my head, adjacent to phone and aerial.' 3. 'I've also noticed migraines to the side of the head which sort of goes away on the weekend when we don't use the mobile phone. But it persists during the weeks since we had the phones.' He concluded the paper with the intent to characterize the syndrome of symptoms associated with mobile phone usage. The symptoms are felt in the temporal, auricular, or occipital areas and were often described as dull or burning pain. [4]The unpleasant sensations may begin within minutes of beginning a call or come on with usage during the day. The symptoms may cease within the hour after a call or last till bedtime. Some cases have symptoms suggestive of intra-cranial effects on vision, inner ear, and cognitive function. Because mobile telephones tend to be used in noisy situations, the user holds the instrument much more tightly to the ear than he does a normal phone. In the opinion of the author, there is good theoretical and clinical evidence to support the hypothesis that some people, perhaps 5% to 8% of mobile phone users, have transient symptoms of vestibular disturbance associated with their use. It is not only during the daytime that mobile phones harm the quality of living.[5] The harmful effects of daytime exposure to radiofrequency are even more marked during sleep. Regular cell phone users are more prone to feel drained and lack energy during the early morning. Some people get up in the middle of the night just to check on their cell phones thus reducing the duration of uninterrupted sleep. The main health risk is less time in the deeper stages of sleep that can help the body recuperate. It is suggested that regular late-night

Volume 5, Issue 3; May-June 2022; Page No 1415-1421

mobile use by teenagers may even lead to mood and personality changes [6]

Methods

This Cross-sectional analytical study was conducted over 1 year at Aarupadai Veedu Medical College & Hospital, Pondicherry. Collaborative departments in the study were physiology & school of audiology .100 cases (frequent mobile phone users) from the second year to final year are screened for their cell phone usage patterns and those who have been using mobile phones for 5 years or more will be considered as cases. Group a-50 cases use of cell phone <5 years, group -b 50 cases use of cell phone >5 years. The following tests will be performed on the subjects recruited for the study as per our inclusion criteria: Pure tone audiometry (PTA), Oto-acoustic emission (OAE), and Brainstem auditory evoked potential (BERA) in the speech therapy department of our Institute. Pure tone audiometry will be done by Alps advanced digital -2000+ machine. Distortion product Oto-acoustic emission will be done by Neurosoft-neuro audio machine standardized by IEC-601-1:1988 and IEC-60601-1-1:2000 standards. Brainstem auditory evoked potential will be recorded using EMS (INCO) machine. PTA, OAE, and BERA are all non-invasive procedures with no risk to participants.

Within10 msec following an appropriate acoustic stimulus, a direct recording from different levels of the subcortical auditory pathway would give a series of potentials corresponding to the sequential activation of the peripheral, pontomedullary, pontine, and midbrain portions of the auditory pathway. When these acoustic nerve and brainstem potentials are volumes conducted to surface recording electrodes placed at the vertex and the mastoid process, they are seen to form a composite series of vertex-positive and vertex-negative waves known as the brainstem auditory evoked potentials.BAEPs can help in detecting hearing loss in children who cannot be tested behaviorally. Its great advantages are that it does not require the cooperation of the child and provides replicable measurements of latency, amplitude, and threshold. Click stimuli delivered to one or both ears evoke seven submicrovolt vertex-positive waves that appear at the human scalp in the first 10 msec after each stimulus. Waves I, III, and V are constant and reproducible, while waves II, IV, VI, and VII are variable and frequently asymmetrical or absent. The most important criterion which is routinely used is the prolongation of IPL (recorded at a click rate of 10/sec) beyond the 99% TL (mean +3SD). There is low inter-individual variability of IPLs.

Recording parameters: Ideally done in a quiet, air-conditioned room (27-29ºC). The external ear canal should be examined to rule out blockage by earwax. Stimulus: The subject's hearing threshold for both ears is determined at the time of testing. Rarefaction clicks at a rate of 10 pulses per second are generated by passing 0.1 msec square pulses through shielded headphones. Stimulus intensity is kept 60 dB above the subject's hearing threshold. During monaural testing, the contralateral ear is masked by the white noise of 30dB HL. Signal-to-noise ratio: The evoked potentials (desired signal) appear against a background of spontaneous electrical activity (noise). Normally, the signal is of much lower amplitude than the noise. To detect an evoked potential it is essential to increase the signal-to-noise ratio.

Statistical analysis: The data obtained by different hearing tests will be compared with their respective normative data (Independent T-test) and hearing loss will be assessed. Regression equations will be derived depending on the duration of exposure of the mobile phone.

Table 1 Comparison of mean anthropometric parameters between the study groups (N=100)

Parameter	Study Group (Mean± SD)		Independent sample t-test P-value
	Group -A (N=50)	GROUP -B (N=50)	
Height	156.34 ± 8.47	156.72 ± 10.08	0.839
Weight	56.46 ± 9.78	58.48 ± 10.54	0.323

Volume 5, Issue 3; May-June 2022; Page No 1415-1421

BMI	23.11 ± 3.63	23.9 ± 4.29	0.321

TABLE :1 The mean height in Group-A was 156.34 ± 8.47, and it was 156.72 ±10.08 in Group -B. The mean weight in Group -A 56.46 ± 9.78, it was 58.48±10.54 in Group B. The mean BMI in Group -A was 23.11±3.63, and it was 23.9 ± 4.29 in Group -B. The difference in anthropometric parameters between the two groups was statistically not significant. (P-value >0.05).

Table 2: Comparison Of Snhl By Pta In Both Ears Between Study Group (N=100)

SNHL by PTA in both ear	Study Group		Chi-square	P value
	GROUP A (N=50)	GROUP B (N=50)		
Normal	7 (14%)	32 (64%)	26.272	<0.001
Abnormal	43 (86%)	18 (36%)		

Table:2 Among group -a 7 (14%) had normal PTA, and 43 (86%) had abnormal.PTA. Among group -b 32 (64%) had normal PTA and 18 (36%) had abnormal PTA. The difference in the proportion of PTA between the two groups was statistically significant. (P-value <0.001).

Table 3: Comparison of BERA latency between study groups (N=200)

BERA Wave Latency	Study Group in both ear		Chi-square	P-value
	GROUP -A (N=100)	GROUP -B (N=100)		
Normal	14 (14%)	19 (19%)	0.907	0.341
Abnormal	86 (86%)	81 (81%)		

Table :3 The difference in the proportion of PTA between the two groups was statistically significant. (P-value <0.001). There was no statistically significant difference in BERA latency between-group -a & group -b, P-value of 0.341(>0.05).

Table 4: Comparison of mean of BERA latenciesleft ear between the study groups (N=100)

BERA latencies In the Left ear	Study Group (Mean± SD)		Independent sample t-test P-value
	GROUP A (N=50)	GROUPB (N=50)	
Absolute latency			
I	1.74 ± 0.6	1.63 ± 0.51	0.307
II	2.85 ± 0.64	2.58 ± 0.61	0.034
III	3.87 ± 0.67	3.62 ± 0.68	0.065
IV	4.93 ± 0.87	4.6 ± 0.72	0.042
V	5.78 ± 0.91	5.26 ± 0.77	0.002
Interpeak latency			
I- III	2.13 ± 0.6	2.02 ± 0.64	0.393
I- V	4.05 ± 0.85	3.66 ± 0.64	0.011
III- V	1.92 ± 0.62	1.66 ± 0.54	0.032

Volume 5, Issue 3; May-June 2022; Page No 1415-1421

There was a statistically significant increase in the absolute latency of waves II, IV, V, and interpeak latency waves I- V, III- V in the left ear. There was no statistically significant difference in BERA left ear latencies I, III, I - III between-group -a & group b (P-value >0.05).'

Table 5: Comparison of mean of BERA latencies in right ear between the study groups (N=100)

BERAlatencies In Right ear	Study Group (Mean± SD)		Independent sample t-test P value
	GROUP A (N=50)	GROUPB (N=50)	
Absolute latency			
I	1.67 ± 0.63	1.55 ± 0.51	0.305
II	2.84 ± 0.72	2.49 ± 0.63	0.012
III	3.91 ± 0.71	3.59 ± 0.71	0.028
IV	4.89 ± 0.81	4.56 ± 0.84	0.047
V	5.75 ± 1.01	5.23 ± 0.93	0.008
Interpeak latency			
I- III	2.24 ± 0.63	2.08 ± 0.66	0.220
I- V	4.19 ± 1.1	3.67 ± 0.81	0.008
III- V	1.85 ± 0.57	1.64 ± 0.6	0.074

Table:5 There was a statistically significant increase in the absolute latency of waves II, IV, V, and interpeak latency waves I- V, III- V in the Right ear. There was no statistically significant difference in BERA left ear latencies I, III, I - III between-group -a & group b (P-value >0.05).' Among people with normal BERA wave latency, there was no statistically significant difference in right and left ears between the two groups with a P-value of 0.095. Among people with normal BERA wave latency, there was no statistically significant difference in males and females between the two groups with a P-value of 0.393. Among people with abnormal BERA wave latency, there was no statistically significant difference in males and females between the two groups with a P-value of 0. 668

Table 6: Comparison of BERA wave latency in maleS and femaleS between study groups

Study Group	BERA wave latency			
	Normal		Abnormal	
	Male	Female	Male	Female
Group -A	8 (57.14%)	6 (42.86%)	46 (53.49%)	40 (46.51%)
GROUP-B	8 (42.11%)	11 (57.89%)	46 (56.79%)	35 (43.21%)
P value	0.393		0.668	

Table:6 Among people with normal BERA wave latency there was no statistically significant difference in males and females between the two groups with a P-value of 0.393. Among people with abnormal BERA wave latency, there was no statistically significant difference in males and females between the two groups with a P-value of 0.668.

Volume 5, Issue 3; May-June 2022; Page No 1415-1421

Discussion

The mobile phone emits electromagnetic frequencies at a range of 900-1800 M Hz and thus, the radiation gets transmitted directly to the ears and head of the individual. Chronic exposure might also cause permanent damage to the surrounding tissues. The adverse effects of excess mobile phone usage include damage to the inner ear, brain tumors, and leukemias. Many road traffic accidents are also attributed to this mobile phone usage. [7] Other harmful effects are headache, lack of concentration, cognitive impairment, and also, possibly DNA damage Hearing dysfunction and hearing loss is the commonest issue associated with this frequent mobile phone usage as there is a major risk of damage to the Organ of the Corti as being directly exposed. Al-K Thamir et al. showed that there was a higher hearing threshold for Pure tone audiometry infrequent mobile phone users compared to non-frequent mobile phone users. Also, there was an impaired otoacoustic emission in the study group suggesting damage to the cochlea. [8] Reiser HP, P et al. found that there was a significantly high frequency of hearing loss in the dominant ear of the persons exposed to frequent mobile phone radiation than in the non-dominant ear. [9] Freude G et al. screened the study population with pure tone audiometry and found that there was a significant rise in the threshold for both air and bone conduction in chronically exposed persons. The pathophysiology behind these changes in the hearing function might be attributed to damage to the structural and functional properties of the cell membrane due to excess exposure to radiofrequency. Higher frequency sound is generally transmitted by the base of the cochlea and it is the first to be affected in case of hearing loss due to loud noise. Speech can also be affected in a person with high-frequency hearing loss. [10]A recent study concluded that short-term exposure to mobile phone EMFs did not affect the transmission of sensory stimuli from the cochlea up to the midbrain along the auditory nerve and the brainstem auditory pathways. [11]A study in Poland evaluated the ABRs in 45 young healthy volunteers before, during, and after exposure to EMFs generated by the antenna of a mobile phone. The ABR waveforms showed no significant difference due to exposure, suggesting that short-term exposure to mobile phones did not affect the transmission of sensory stimuli from the cochlea up to the midbrain along the auditory nerve and the brainstem auditory pathway. A study was done on the student population in the UK on the adverse effects of mobile phones on the auditory pathway. [12]Duration of ownership and daily usage ranged between 0–7 years and 0–45 min respectively. The results of the study confirmed that the prevalence of mobile phone ownership among the student population is extremely high. However, there appear to be no harmful effects of mobile phone usage on their audiovestibular systems within the range of exposure of the study, in so far as can be detected by the self-reporting method employed. All these negative findings in most of the studies should not encourage mobile phone usage because minor biological and neurophysiological influences may not be detected with the current technology. [13]A recent study in rabbits in the year 2011 investigated the ABRs during exposure to electromagnetic radiation emitted by cellular phones. [14]The prolongation of interval latencies I–V and III–V indicates that exposure to EMFs emitted by mobile phones can affect the normal electrophysiological activity of the auditory system, and these findings fit the pattern of general responses to a stressor. A study conducted in Saudi Arabia concluded that 60 min of exposure to EMFs emitted by mobile phones had an immediate effect on the hearing threshold assessed by pure-tone audiometry and inner ear (assessed by DPOAE) in young human subjects. It may also lead to other otologic.[15]

Conclusion

In our opinion, the pathological dependence on mobile also fulfills the criteria of so-called “Mobile or Cell Dependence Syndrome” resembling substance Dependence Disorder, producing predominantly ‘Psychological Dependence’. Mobile phone use can be considered as one of the socialized forms of addiction or dependence. Along with renal, ophthalmic, and cardiovascular screenings, diabetic patients should undergo regular auditory screenings. But further studies are necessary to evaluate the sensitivity and specificity of the BERA testing. If changes in the organ of the Corti are detected before DO a noninvasive diagnostic procedure like BERA will help degree of serious complications that may cause hearing loss. However, continued exposure over 10 years may increase the latency of waves I and II representing the peripheral portion of the auditory pathway. However additional studies are

Volume 5, Issue 3; May-June 2022; Page No 1415-1421

needed to study the long-term effects of mobile phone usage. In addition as a new generation of mobile sources of EMFs (such as 5G and smartphones) are being rapidly introduced, it is of utmost importance to establish whether or not these new generations of mobile phones have potential adverse effects on brain functions in humans

References

1. Parazzini M, Brazzale AR, Paglialonga A, Tognola G, Collet L, Moulin A. Effects of GSM cellular phones on human hearing: the European project "GUARD" *Radiat Res.* 2007;168:608–613.
2. Stefanics G, Kellényi L, Molnár F, Kubinyi G, Thuróczy G, Hernádi I. Short GSM mobile phone exposure does not alter human auditory brainstem response. *BMC Public Health.* 2007;7:325.
3. Mailankot M, Kunnath AP, Jayalekshmi H, Koduru B, Valsalan R. Radiofrequency electromagnetic radiation (RF–EMR) from GSM (0.9/1.8 GHz) mobile phones induces oxidative stress and reduces sperm motility in rats. *Clinics.* 2009;64:561–565.
4. Schoemaker MJ, Swerdlow AJ, Ahlbom A, Auvinen A, Blaasaas KG, Cardis E, et al. Mobile phone use and risk of acoustic neuroma: results of interphone case-control study in five North European countries. *Br J Cancer.* 2005;93:842–848.
5. Ozturan O, Erdem T, Miman MC, Kalcioglu MT, Oncel S. Effects of the electromagnetic field of mobile phones on hearing. *Acta Otolaryngol.* 2002;122:289–293.
6. Kaprana AE, Karatzanis AD, Prokopakis EP, Panagiotaki IE, Vardiambasis IO, Adamidis G. Studying the effects of mobile phone use on the auditory system and the central nervous system: a review of the literature and future directions. *Eur Arch Otorhinolaryngol.* 2008;265:1011–1019.
7. Salama OE, Abou El Naga RM. Cellular phones: are they detrimental? *J Egypt Public Health Assoc.* 2004;79(3–4):197–223.
8. Al-K Thamir, Sultan AM. Association of mobile phone radiation with fatigue, headache, dizziness, tension, and sleep disturbances in Saudi population. *Saudi Med J.* 2004;25(6):732–736.
9. Reiser HP, Dimpfel W, Schober F. The influence of electromagnetic waves on human brain activity. *Eur J Med Res.* 1995;1:27–32.
10. Freude G, Ullsperger P, Eggert S, Ruppe I. Effects of microwaves emitted by cellular phones on human slow brain potentials. *Bioelectromagnetics.* 1998;19:384–387.
11. Eulitz C, Ullsperger P, Gabriele F, Elbert T. Mobile phone module response patterns on human brain activity. *Neuroreport.* 1998;9(14):3229–3232
12. Kellenyi L, Gy Thuroczy, Faludy B, Lenard L. Effects of mobile GSM radiotelephone exposure on the auditory brainstem response. *Neurobiology.* 1999;7:79–81.
13. Preece AW, Iwi G, Davies-Smith A, Wesnes S, Butler S, Lim E, et al. Effects of a 915-MHz simulated mobile phone signal on cognitive function in man. *Int J Radiat Biol.* 2012;75:447–456.
14. Borbely AA, Huber R, Graf F, Fuchs B, Gallman E, Achermann P. Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram. *Neurosci Lett.* 1999;175:207–210.
15. Koivisto M, Revonusuo A, Krause C, Haarala S, Sillanmaki L. Effects of 902 MHz electromagnetic fields emitted by cellular telephones on response times in humans. *Neuro Report.* 2000;11(2):413–415.

Volume 5, Issue 3; May-June 2022; Page No 1415-1421