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Original Research Article

Effect of Duration of Usage of Mobile Phone on Visual Evoked Potentials

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ABSTRACT

Background and Aim: Mobile phones (MP) have changed the way people work and communicate. They are now an essential part of business, commerce and communication. Concerns continue to be raised about potential adverse health impacts associated with their use. There is scarcity of data in the literature concerning the effect of electromagnetic radiation (EMR) emitted from MP on human visual system using visual evoked potentials (VEP) as the assessment tool.
Therefore, the present study was planned to evaluate the effect of duration of usage of MP on human visual system by recording of pattern reversal visual evoked potentials (PRVEP).
Materials & Methods: 50 healthy subjects of either sex within the age group 18-40 years were recruited and divided into two groups. Those using MP for less than or equal to 6 years were placed in group I and those using MP for more than 6 years were put in group II. Monocular pattern reversal visual evoked potentials (PRVEP) were recorded using standard protocol. Latencies and amplitude of various waveforms were calculated and studied.
Results: A statistically significant (p value <0.05) difference in mean latencies and amplitude of various PRVEP waves was observed between two groups. Latencies were longer and amplitude was smaller in group II as compared to group I in both eyes.
Conclusion: The findings of our study suggest that EMR emitted from MP influences visual system. Changes cumulate over time as evidenced by longer latency and smaller amplitude in those using MP for more period of time (group II).

Keywords: electromagnetic radiation, mobile phone, pattern reversal visual evoked potential.

INTRODUCTION

The 21st century is undoubtedly the era of mobile phone (MP) communications. Mobile phones have changed the way people work and communicate. MP are used not only to keep in touch with relatives and friends but are also used as a platform for expressing one's identity and as a source of entertainment. [1] MP as a symbol of electronic century and digital world has spread worldwide especially in youth. Subscribers of MPs increased from 12.4 million in 1990 to 500 million in 2000 to 3.3 billion in 2008 and 5.3 billion at the end of 2010. [2,3] They are now an essential part of business, commerce and communication. The widespread use of MP has resulted in increased human exposure to the electromagnetic waves (EMW) emitted from them. Concerns continue to be raised about potential adverse health impacts associated with their use. [4,5]

Mobile phone technology has changed considerably since its inception with the earlier analogue phones being replaced gradually by digital ones. Analogue phones operated at a higher power than digital phones, emitting more electromagnetic radiation (EMR). MP typically operates at frequencies of 450-

900MHz (analogue systems), 1800-1900MHz (digital systems) and 1900-2200MHz (Universal Mobile Telecommunications System). [6] Peak power output of MP antenna is about 8-15 W (450 MHz), 2W (900 MHz) and 1W (1800 MHz). [7] Part of the EMR emitted by a MP is absorbed by the body. The rate at which energy is absorbed by the human body is measured by "Specific Absorption Rate" (SAR) and its maximum level for modern handsets have been set by governmental regulating agencies in many countries. In the USA and India, the SAR limit is 1.6W/Kg, averaged over a volume of 1g of tissue. [8,9]

The close approximation of eyes including visual pathways to MP antenna during a phone call exposes these tissues to excessive EMR. Eyeballs are hotspots of EMR because of their anatomy and composition. [10] Eyes having fewer blood vessels than other organs are more vulnerable to heating effects of EMR. EMW from MP have the potential to damage eye tissues. [11] So, there is a strong rationale for determining the deleterious effects of EMW generated from MP on the human visual system. However, very few studies have been carried out in this regard. Therefore, the present study was planned to assess the effect of duration of usage of MP on human visual system by recording of pattern reversal visual evoked potentials (PRVEP).

MATERIALS AND METHODS

The present study was conducted in 50 healthy subjects of either sex in the age group 18-40 years at the electrophysiology lab in the department of Physiology, Pt. B.D. Sharma PGIMS, Rohtak. Subjects were recruited from staff members, medical students and healthy attendants accompanying the patients coming to the institute. Pattern reversal visual evoked potentials (PRVEP) were recorded in subjects after taking their informed consent. Ethical clearance was obtained from institutional ethics committee.

Inclusion criteria

Healthy subjects of either sex in the age group 18-40 years willing for the test.

Exclusion criteria

- Presence of any illness that could influence visual evoked potentials
- Best corrected visual acuity worse than 6/60
- Extreme pupil sizes
- History of major illness like diabetes, hypertension

Recording of PRVEP was done on RMS EMG EP MK2 machine using the following settings:

Stimulation

- Black and white checkerboard
- Contrast - 70%
- Full field size > 8^o
- Size of pattern - 8x8 min
- Rate of stimuli - 1.5Hz
- Mean luminance of the central field - 50cd/m^2
- Background luminance - 30cd/m^2

Recording conditions

- Low filter - 2Hz
- High filter - 100Hz
- Sweep duration -300ms
- Number of epochs - 100
- Sweep speed - 50ms/division
- Sensitivity - 2microvolt/division

The volume conducted evoked responses were picked up from scalp by using disc type of Ag/AgCl electrodes placed as per 10-20 international system of placement. An active electrode was placed on the scalp over the visual cortex (O_z) with ground electrode on the forehead (F_z). Two reference electrodes were attached to right and left mastoid designated as O_1 and O_2 respectively. All the electrodes were plugged to a junction box. Skin to electrode impedance was monitored and kept below 5Kohms. Two channel recording was done using the following montage: [12]

Channel 1: O_Z - O_1
Channel 2: O_Z - O_2
Ground electrode: F_Z

Procedure

Subjects were explained all about the procedure and their informed written consent was obtained. Subjects were asked to sit on a table in relaxed position about 100 cm from the monitor. The visual stimuli consisting of black and white checks generated by a TV system reversing at the rate of 1.5 Hz was presented to one eye with other eye being covered. Subjects were instructed to focus on a rectangle displayed at the centre of the screen. Total 100 stimulations were presented monocularly. The signals were picked up by the electrodes and filtered, amplified, averaged, displayed on the screen of RMS EMG EP MK2 and recorded.

The normal recording of PRVEP consisted of 3 waves: N75, P100 and N145. Latencies of waves N75, P100 and N145 and amplitude of P100 from the preceding N75 peak was measured from the recordings and data were entered in the subject's proforma.

Statistical analysis

The mean and standard deviation for latencies and amplitude of PRVEP waves was calculated. The data was analyzed statistically using student t-test and p-values were obtained. The statistical analysis was carried out using SPSS PC software version 13.0.

P value >0.05 was considered as not significant.

P value <0.05 was considered as significant.

P value <0.01 was considered as highly significant.

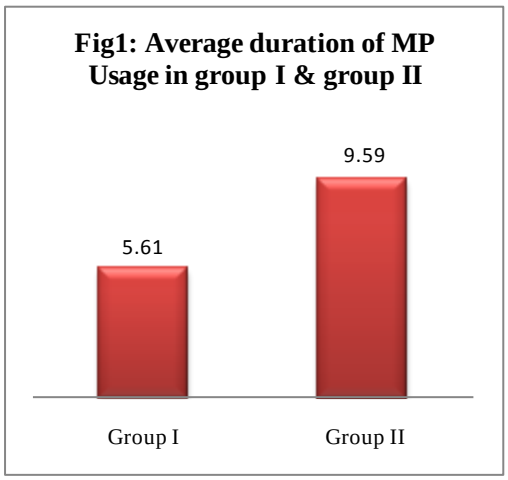
RESULTS

Table 1: Distribution of subjects as per total duration of mobile phone usage

Total duration of MP usage (Yrs)	Number of Subjects
≤ 6 (Group I)	28 (56%)
> 6 (Group II)	22 (44%)

The present study tested VEP latencies and amplitude in age matched healthy subjects divided into 2 groups depending upon the total duration of MP usage. Group I included subjects using MP for a period of less than or equal to 6 years and those using MP for more than 6 years were placed in group II. Distribution of subjects in two groups is shown in the table1.

Average duration of mobile phone usage in group I was 5.61 ± 0.50 yrs while in group II; it was 9.59 ± 2.04 yrs (figure1).



Average latency of all the waves was found to be longer in group I as compared to group II both in right eye as well as left eye and the difference was statistically significant. A statistically significant difference in amplitude of P100-N75 in both eyes was also observed between group I and group II with large amplitude in group I (table2, table3).

Table2: Comparison of Latencies and Amplitude of PRVEP waveform in Right Eye between Group I and Group II

Wave	Group I (Mean ± SD)	Group II (Mean ± SD)	P value
N75 (ms)	66.82 ± 5.25	69.47 ± 4.90	<0.05*
P100 (ms)	100.07 ± 7.96	103.58 ± 5.50	<0.01**
N145 (ms)	144.13 ± 14.68	154.53 ± 13.10	<0.05*
P100-N75 (μV)	4.41 ± 2.42	3.60 ± 1.87	<0.05*

*statistically significant, **highly significant

Table3: Comparison of Latencies and Amplitude of PRVEP waveform in Left Eye between Group I and Group II

Wave	Group I (Mean ± SD)	Group II (Mean ± SD)	P value
N75 (ms)	66.12 ± 5.16	68.08 ± 5.98	<0.05*
P100 (ms)	99.72 ± 6.97	102.85 ± 6.30	<0.01**
N145 (ms)	146.09 ± 13.82	151.85 ± 12.18	<0.05*
P100-N75 (μV)	4.37 ± 2.47	3.98 ± 1.89	<0.05*

*statistically significant, **highly significant

DISCUSSION

Mobile phones (MP) have been widely used in popular telecommunication and medical telemetry systems. They have

become indispensable as communication tools. The tremendous use of MP has drastically increased the amount of EMR exposure in our daily lives. There are fears that the EMR emitted from MP causes various adverse health effects. The list of such alleged effects is virtually endless. [13] Due to its natural sensitivity to radiation; eye has been the focus of many research programs. However, there is scarcity of data in the literature concerning the effects of EMR on visual system using visual evoked potential (VEP) as tool of assessment. In our study, we tried to evaluate the same. Visual evoked response testing has been one of the most exciting clinical tools to be developed from neurophysiologic research in recent years and has provided us with an objective method of identifying abnormalities of visual pathways. VEPs better quantify functional integrity of the optic pathways than scanning techniques such as magnetic resonance imaging (MRI). [14]

In our study, it was found that latency of all three waves (N75, P100, and N145) was longer in group II as compared to group I in right eye as well as left eye. The change was statistically highly significant (p value <0.01) for wave P100 (clinically most useful parameter). A statistically significant difference in amplitude of P100-N75 was also observed in both the eyes between two groups with lager amplitude in group I. The latency and shape of P100 depend upon the surviving fastest conducting fibres. The commonest cause of prolonged P100 latency is demyelination in the optic pathways. [15] Conditions leading to axonal loss such as ischemic optic neuropathy produce decreased amplitude. The amplitude of P100 has a wide inter-individual variability reducing its clinical utility. [16]

EMR emitted from MP can affect the biological tissues via thermal and non-thermal effects. Numerous animal studies are there to report the same. One well-understood effect of EMR emitted from MP is dielectric heating, in which any dielectric material (such as living tissue) is heated by rotations of polar molecules induced by the electromagnetic field. [17] Baranski reported edema and heat lesions in the brain of guinea pigs exposed in a single 3-h session to 3000-MHz radiofrequency radiation (RFR) at a power density of 25 mW/cm^2 (SAR 3.75 W/kg). [18] Switzer and Mitchell also reported an increase in myelin degeneration of neurons in the brain of rats at 6 weeks after repeated (5 h/day, 5 day/week for 22 weeks) exposure to continuous wave 2450-MHz RFR (SAR 2.3 W/kg). [19] A power density dependent decrease in latency of some of the late components of thalamic evoked potentials was reported by Johnson and Guy. They concluded that EMR affects multisynaptic neural pathways. [20]

CONCLUSION

From the findings of this study, it can be reasonably concluded that EMR emitted from MP affects visual system especially visual pathways. The changes are cumulative in nature as evidenced by longer latency and smaller amplitude in those using MP for longer period of time (group II). The findings obtained calls for further research in this area seeking an underlying mechanism for the observed changes.

Conflict of interest: Authors declare they have no conflict of interest.

ABBREVIATIONS: EMR - Electromagnetic radiation, MP - Mobile phone, VEP - Visual evoked potential, PRVEP - Pattern reversal visual evoked potential

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