Effect Of Electromagnetic Waves Emitted From Mobile Phone On Brain Stem Auditory Evoked Potential In Adult Males

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Abstract

Mobile phone (MP) is commonly used communication tool. Electromagnetic waves (EMWs) emitted from MP may have potential health hazards. So, it was planned to study the effect of electromagnetic waves (EMWs) emitted from the mobile phone on brainstem auditory evoked potential (BAEP) in male subjects in the age group of 20-40 years. BAEPs were recorded using standard method of 10-20 system of electrode placement and sound click stimuli of specified intensity, duration and frequency. Right ear was exposed to EMW emitted from MP for about 10 min. On comparison of before and after exposure to MP in right ear (found to be dominating ear), there was significant increase in latency of II, III (p<0.05) and V (p<0.001) wave, amplitude of I-Ia wave (p<0.05) and decrease in IPL of III-V wave (P<0.05) after exposure to MP. But no significant change was found in waves of BAEP in left ear before vs after MP. On comparison of right (having exposure routinely as found to be dominating ear) and left ears (not exposed to MP), before exposure to MP, IPL of III–V wave and amplitude of V–Va is more (<0.001) in right ear compared to more latency of III and IV wave (<0.001) in left ear. After exposure to MP, the amplitude of V–Va was (p<0.05) more in right ear compared to left ear. In conclusion, EMWs emitted from MP affects the auditory potential.

Introduction

Since large numbers of persons are using the mobile phones (MPs) emitting the electromagnetic waves (EMWs), effect of these waves on health even in small quantity could have major public health consequences (1, 2). The effects of EMWs depend on limit of exposure and distance from source. The electromagnetic radiations (EMR) or EMWs interfere with electrical impulses through which two neurons remains connected with each other. This interference can lead to deafness and migraine (3), sensation of burning or warmth around the ear, headache, disturbance in sleep, and memory loss (4). The ear is closest organ exposed to MP and this may cause high energy deposition in the ear compared to other parts of body (5). There is limited knowledge about interaction of EMWs and auditory functions. So, it was planned to study the effect of acute exposure of electromagnetic waves (EMWs) emitted from the mobile phone on auditory functions by recording of

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exposure to the mobile phone from both ears. Then subjects right ear was exposed to EMWs emitted from MP for a period of 10 minutes (4) (average duration of a common phone call). During that time examiner was reading a fixed text from newspaper into one mobile phone, which the subject was hearing through another mobile phone (GSM type, SAMSUNG model) (10) kept near to right ear at usual distance as used to hear to MP. BAEP was again recorded after the exposure from both ears. Recording of BAEP consists of the absolute peak latencies (msec) of waves I, II, III, IV and V together with interpeak latencies (IPL) (msec) of I-III, III-V and I-V waves and the amplitudes (µV) of wave I and V (9). Study was cleared by ethical committee. Statistical analysis was done by paired “t” test.

Results

All subjects were male, with mean height 157±38.09 cm, mean weight 62±8.93 kg. Duration of use of MP ranged from 5-8 years (mean 6.2±1.2), per day exposure to MP was 30 min - 9hours (mean 2.86±2.31 hours), duration of per call was 2-30 min. (mean 10.2±3.75) min, duration of exposure to MP while recording of BAEP was 6.8±2.3 min. Subjects using MP were Samsung by 6, Nokia by 5, Spice by 2, Micromix by 1and Voda phone by 1 subject. Out of 15 subjects right ear dominance was seen in 11 subjects and left ear was in 4 subjects. When BEAP was compared in right ear (found to be dominating ear as it was used to hear the MP by most of the subjects and this ear was also exposed to MP in this study) before and after exposure to MP, there was significant increase in latency of II, III (p<0.05) and V (p<0.001) waves and amplitude of I-Ia wave (p<0.05) along with decrease in IPL of III-V waves.

Materials and Methods

Study was carried out in 15 healthy (7) male (8) subjects in the age group of 20-40 years, who were using the MP for the last 5-8 years with per day exposure of > 30 min. After explaining the procedure, consent was taken and recording was done on computerized evoked potential recorder (RMS EMG MK-2) using 10/20 system of electrode placement and standard click stimuli. Active electrode (Ag/AgCl disk electrodes) was placed at Cz, reference electrodes on the mastoid at A1 and A2 and the ground electrode at Fz. The click stimuli of intensity 70 db above normal hearing threshold at the rate of 10/sec and of 0.1msec duration square pulses through shielded head phone were presented monaurally with alternate polarity. The other ear was masked by noise 40 db. The skin to electrode impedance was kept below 5 kohms. The signals picked up by electrodes were filtered (at 100 Hz and 3 KHz), amplified, averaged and displayed on the screen (6, 8, 9). Subjects were excluded with history of any clinical condition possibly implicated in hearing loss (age, diabetes mellitus, cardiovascular disease, hyperlipedemia, history of acoustic trauma); presence of ear/nose/throat infection or pathology in otoscopic examination; noise induced hearing loss (occupational); smoking; tobacco chewing; and, symptoms related to hearing. Waves of BAEP were recorded before and after exposure to MP. So, first potentials were recorded in a condition of rest before exposure to the mobile phone from both ears. Then subjects right ear was exposed to EMWs emitted from MP for a period of 10 minutes (4) (average duration of a common phone call). During that time examiner was reading a fixed text from newspaper into one mobile phone, which the subject was hearing through another mobile phone (GSM type, SAMSUNG model) (10) kept near to right ear at usual distance as used to hear to MP. BAEP was again recorded after the exposure from both ears. Recording of BAEP consists of the absolute peak latencies (msec) of waves I, II, III, IV and V together with interpeak latencies (IPL) (msec) of I-III, III-V and I-V waves and the amplitudes (µV) of wave I and V (9). Study was cleared by ethical committee. Statistical analysis was done by paired “t” test.

<table>
<thead>
<tr>
<th>Latency (msec)</th>
<th>Interpeak Latency (msec)</th>
<th>Amplitude (µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Before</td>
<td>1.63±0.43</td>
<td>3.0±0.50</td>
</tr>
<tr>
<td>After</td>
<td>1.69±0.34</td>
<td>3.02±0.35</td>
</tr>
<tr>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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</table>

NS - Nonsignificant; p<0.001 - highly significant.
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(P<0.05) after exposure to MP (comparing the acute effect of exposure to already chronically exposed ear). But no significant change was recorded in BAEP of left (unexposed) ear before vs after exposure to MP. When right and left ears were compared before exposure to MP, IPL of III-V waves and amplitude of V-Va is more (<0.001) in right ear (chronically exposed) compared to more latency of III and IV waves (<0.001) in left (unexposed) ear. After exposure to EMWs, the amplitude of V-Va wave was (p<0.05) more in right vs left ear (acute effect) (Table I and Table II, Fig. 1 and Fig. 2).

Discussion

Study was carried out in fifteen (7) healthy male subjects, keeping the gender constant as females have shorter latency and higher amplitude of BEAP (8).

Different waves of BAEP have been correlated with activity of different areas of brainstem auditory pathway. So changes in latency and amplitude of waves of BAEP provide information about their dysfunction as II, III, V component of BAEP primarily represent conduction of electrical activity at cochlear nucleus, pons and midbrain respectively (6). The interpeak latencies (IPL) between these components reflect neural conduction in corresponding segment of central auditory pathway. It is useful in assessment of hearing in early subclinical neurological dysfunction and demyelinating diseases (8, 11).

MP transmits and receives microwave radiations at

<table>
<thead>
<tr>
<th>Wave</th>
<th>Latency (msec)</th>
<th>Interpeak Latency (msec)</th>
<th>Amplitude (µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Before</td>
<td>1.64±0.32</td>
<td>2.85±0.29</td>
<td>3.66±0.26</td>
</tr>
<tr>
<td>After</td>
<td>1.68±0.29</td>
<td>3.0±0.56</td>
<td>3.80±0.49</td>
</tr>
<tr>
<td>NS</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS - Nonsignificant; p <0.05 - significant; p <0.001- highly significant.

Fig. 1: Brainstem Auditory Evoked Potential (BAEP): before and after exposure to MP in right ear.
frequencies of 900 and 1800 MHz. The hearing system, particularly the cochlear outer hair cells, is known to be highly sensitive to electrical and magnetic fields (4). Increase in latency of II, III, V waves after exposure to MP in right ear (exposed and found to be dominating ear in present study) indicates that transmission of sensory impulse in the region of cochlear nucleus, pons and midbrain is affected by EMWs. This also demonstrates changes in excitability of neuronal pool of upper part of brainstem. Other possible mechanisms behind these findings may be due to free radicals formation, significant changes in antioxidant enzymes (SOD, GPx, CAT, MDA), increase in Ca++ permeability, impaired synaptic transmission, changes in level of biomarkers i.e., caspase-3, creatine kinase, and hormonal imbalance (melatonin) in brain (2).

Amplitude of the components of evoked response are proportional to number and size of fibers that are depolarized and provide an estimate of amount of active neural tissues that is functioning (12). Amplitude of V-Va wave was found to be more in right ear (chronically exposed ear) compared to left (unexposed) ear before exposure to MP, it may be due to cumulative effect of EMW of MP as this ear was used by subjects to hear MP daily for the last 5-8 years (13) and side of exposure may also play important role in producing RFR effects on performance (14). Similarly, increased amplitude of V-Va wave after exposure on right ear than left ear indicate some neurophysiologic effect, as low dose of microwave radiation affect stress proteins and neurons in brain (15), increases temperature (16), increases cerebral blood flow (17). Also on the side of exposure to MP the interference in electrical activities of human body by electromotive forces of MP may produce changes in cognitive functions (18). It is reported that a higher degree of hearing loss is associated with long term exposure to EMWs generated by cellular phones (19-20). Similarly, it is demonstrated that subjects who used MP >60 min/day had hearing threshold of the dominants ear worse than the non dominant ear (21). It is reported that EMWs emitted from MP may cause increase in hearing threshold for pure tone (22). While Ozturan et al did not detect any deleterious effect on hearing level (5). Similarly, in other studies with 10 min exposure to MP did not induce any change in distortion product otoacoustic emission (DPOAE) generation mechanism when compared with real or sham exposure (2) or on transient evoked oto acoustic mission (TEOAE) (23). Similarly, no effect was detected on latency of waves and IPL of auditory brain response (ABR) pattern during or after exposure to electromagnetic field compared to initial ABR pattern in both men and women (24). While
statistically significant increase in latency of wave III and IPL of III-V wave was recorded in children with alternate click stimuli showing some effect on hearing ability (25). In animal experiments, it is seen that no difference was found in latencies of I-IV waves and IPL of I-III waves, and no functional or morphological alteration was detected in outer hair cells of the guinea pig organ of corti after exposure to MP (26). So, this study demonstrates that EMWs emitted from MP affects auditory potential.

References