EFFECT OF ELECTROMAGNETIC WAVES EMITTED FROM MOBILE PHONE ON BLINK REFLEX IN NORMAL HEALTHY MOBILE PHONE USERS

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Abstracts: **Background & objectives**: Electromagnetic wave emitted from mobile phone affects not only the central but also peripheral nervous system. So, it was planned to study the effect of electromagnetic waves (EMW) emitted from mobile phone (MP) on cranial nerves by observing effect on Blink Reflex (BR). **Methods:** BR was recorded by stimulating the supra orbital nerve on both sides by keeping the cathode on supra orbital foramen and anode 2 cm laterally with sweep speed of 10 ms / division, pulse of 100ms duration, and intensity of 15-25 mA. It was recorded before and after 10 min exposure to MP (GSM type, Samsung GT-N7100,902).Active electrode was placed at inferior orbicularis occuli muscle bilaterally and reference electrode at just lateral to the lateral canthus on both sides. Ground electrode was kept at forehead. Statistical analysis was done using paired "t" test. **Results:** In right eye, latency of iR1 and cR2 was increased ($p<0.001$) and iR2 was decreased ($p<0.01$) significantly after exposure to EMW emitted from mobile phone. In left eye, latency of iR1 and cR2 was decreased significantly ($p<0.001$) and latency of iR2 was increased non-significantly, after exposure to EMW emitted from mobile phone. **Conclusion:** Response of right eye was slightly different compare to left eye, as right ear was found to be dominant ear.

Key words: Electromagnetic waves, Mobile Phone, Blink Reflex.

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Introduction:

Eyelid closure in response to stimulus is called blink reflex (BR). Clinically it is evoked by light corneal, eyelash or glabllar touching. It is the electrical analogue of coraneal reflex[1.] Kugelberg elicited BR electro-myographically by stimulating supra-orbital nerve, branch of ophthalmic division of trigeminal nerve[2]. Normal BR shows central or peripheral mechanisms for trigemino-facial pathways in normal or different disorders involving cranial nerves. Since electromagnetic waves (EMWs) emitted from mobile phone (MP) affect central nervous system (CNS) i.e., resting electroencephalogram (EEG) and related cognitive and mental ability[3] , reaction time[4], event related potentials[5] etc. They also affect conduction velocity in ulnar and median nerves[6, 7] in peripheral nervous system (PNS). EMWs emitted from MP allow 75% of energy to penetrate 4-6 cm deep into the brain[8]. In addition, different brain areas respond differently to EMWs[9]. Also mobile phone is kept near to ear, close to face, during talking mode[10]. So, based on this assumption that EMWs might affect cranial nerves, it was planned to study the effect of electromagnetic waves emitted from mobile phone on trigemino - facial blink reflex. Currently almost no information is available on the effect of electromagnetic radiations (EMR) emitted from mobile phone on blink reflex. BR has been shown to be an effective method for evaluating the subclinical involvement of cranial nerves. More so, by advanced neuro-physiological tests, conditions involving peripheral nerves can be identified, but same is not possible for subclinical involvement of cranial nerves[11]. BR was first described in 1896 by Walker Overend –a British human physiologist, who reported it as a new "cranial reflex"[12]. BR has two components: R1 is a short loop reflex, that occurs only on the side of stimulation of supraorbital nerve. R2 is a longer loop reflex, that occurs bilaterally. This response corresponds to the clinically observable blink[13].

Material and Methods:

Study was carried out in fifteen male healthy volunteers in the age group of 20-40 years. Anthropometric measurements were recorded. Whole of the procedure was explained to each subject. Written consent was taken. Subjects with history of neuropathy, limb injury, neuromuscular

transmission disorder, myopathy, alcohol abused, Bell's palsy and earlier cranial nerve involvement, psychiatric or sleep –wake cycle problem, vitamin B12 deficiency, excess coffee intake were excluded. Furthermore, subjects were asked to avoid the use of mobile phone 2-3 hours prior to recording of BR.

Blink reflex recording

Subject was asked to lie down in supine position, relaxed with closed eyes in quit room having comfortable temperature. Recording was taken from both the eyes. Active electrode was placed at inferior orbicularis occuli muscle bilaterally and reference electrode at just lateral to the lateral canthus on both sides. Ground electrode was kept at forehead. Right and left supraorbital nerves (branch of ophthalmic division of trigeminal nerve), 1cm from midline at supraorbital notch were stimulated on both sides transcutaneously with cathode placed over supraorbital foramen and anode about 2 cm higher and rotated laterally at an oblique angle to avoid the spread of current to the contralateral supraorbital nerve [14]. Sweep speed was set at 10ms / division, sensitivity was 200mv /division, filter was at 2Hz to 10kHz, pulse was of 100 ms duration, intensity was at 15-25 mA. Two separate responses were elicited – (i) iR1- an early unilateral response on the side of stimulation (ii) late bilateral response R2 (iR 2 ipsilaterally and cR2 contralaterally). Latency of these responses was measured in millisecond [15]. Amplitude was considered, an unreliable index was not used in any analysis[16].

Exposure to mobile phone

Recording of BR was taken first in resting condition before exposure to mobile phone. Then person was exposed to electromagnetic radiation (EMR) emitted from mobile phone (GSM type, Samsung model GT-N7100, 902 MHz, SAR limit 2.0 W / Kg, average power emitted 0.125-0.25 W / cm2) for ten minutes (duration of usual phone call). For exposure, examiner was reading a fixed text from newspaper into one mobile phone. This text was heard by subject through another mobile phone, held in classical calling position of use (antenna was oriented to temporal parietal region and microphone towards mouth) at a distance of 1.5 cm from tragus of ear (right ear was found to be dominant ear), as this ear was used by subjects to hear the mobile phone[17]. Blink reflex was again recorded after the exposure to mobile phone.

Statistical analysis

Statistical analysis was done using paired "t"test. Values obtained were expressed as mean and standard deviation (SD). P value if found to be less than 0.05 was taken as significant.

Result:

Study was conducted in fifteen male healthy subjects in the age group of 20-40 (mean 32.2 = 6.6) years with body weight varies from 40 to 95 (mean 63.34=14.74) kg, height varies from 155 to 175 (mean 155.86=38.11) cm, subjects were using the mobile phone for the last 5-9 years, per day exposure was >30 min, duration of /call varies from 2min-30 min. No complaint was reported by any subject in relation to use of mobile phone. In right eye, latency of iR1 and cR2 was increased ($p<0.001$) and latency of iR2 was decreased ($p<0.01$) significantly after exposure to EMR emitted from mobile phone. In left eye, latency of iR1 and cR2 was decreased significantly ($p<0.001$) and latency of iR2 was increased non-significantly, after exposure to EMR emitted from mobile phone (Table 1, 2). Response of right eye was slightly different compare to left eye, as right ear was found to be dominant ear.

Table1: Effect of electromagnetic waves (EMW) emitted from mobile phone (MP) on Blink Reflex in mobile phone users on stimulation of right eye. (Mean ± SD)

Latency (ms)	Before exposure to mobile phone	After exposure to mobile phone
iR1	10.34 ± 1.07	10.6 ± 0.76***
iR2	24.21 ± 4.24	23.56 ± 3.37**
cR2	29.62 ± 1.66	30.33 ± 2.43±***

*** = p<0.001--- very significant.

** = p< 0.01---significant.

Table2: Effect of electromagnetic waves emitted from mobile phone on Blink Reflex in mobile phone user on stimulation of left eye. (Mean ± SD)

Latency (ms)	Before exposure to mobile phone	After exposure to mobile phone
iR1	10.08 ± 1.50	9.96 ± 1.59
iR2	24.84 ± 4.46	25. 23 ± 5.71
cR2	31.24 ± 2.69	29.86 ± 1.67

*** = p<0.001--- very significant.

** = p< 0.01---significant.

Discussion:

Electrophysiological studies of blink reflex may be useful in revealing subclinical abnormality of cranial nerves [18]. Cranial nerves are affected in neuropathy, but clinically remain silent. EMWs affect central and peripheral nervous system via their role in imbalance of oxidants and antioxidants, neurotransmitter release, demyelination [19] as both structural and functional loss can be seen on exposure. Myelination is important factor for mediating complex polysynaptic pathway, as those involved in evoked potential and blink reflex[20] . BR testing is an easy and noninvasive technique for evaluating and detecting clinically silent nerve abnormality and it provides data that can not be obtained with other clinical methods [21]. BR reflects integrity of afferent and efferent pathways. The afferent limb of BR or orbicularis occuli reflex is ophthalmic division of trigeminal nerve and efferent limb is facial nerve [21]. The latency of R1 represents conduction time along trigeminal and facial nerves and pontine relay. R2 latency represents excitability of interneurons and synaptic transmission in addition to axonal conduction[1].

Lesions of trigeminal nerve involves afferent limb of reflex arc. They prolong latency of ipsilateral R1 and bilateral R2 when affected side is stimulated (afferent type abnormality) [21]. Facial nerve lesions affect efferent limb of BR arc and delay latency of ipsilateral R1 and R2 regardless of side of stimulation. [22]. In Wallenberg syndrome, which involves medulla, both ipsilateral R1 and contralateral R2 are abnormal when affected side is stimulated[23]. Stimulation of normal side produces normal response. In pontine lesions R1 components has been reported abnormal unilaterally or bilaterally. In comatose state R2 response is nonexcitable on both sides[15].

In normal subjects R2 begins after R1 clearly. This distinction becomes unclear in demyelinating neuropathy[1]. According to Ropper et al (1990) in acute inflammatory demyelinating polyneuropathy (AIDP) demyelination occurs in either facial and /or trigeminal nerves. According to him absent or prolonged ipsilateral or contralateral R2 responses noted in 52% patients. He suggested that abnormal BR may be noted with apparently normal facial strength. Abnormalities of R1 component is more frequent than R2 component[24]. Cruccu et al (1998) demonstrated that in diabetic neuropathy mean latency of R1 and R2 is slightly longer than control value. Prolonged latency of R1 represents sum of mild facial and /or trigeminal nerve abnormality[25]. Similarly Nazliel observed increased latency (which was significant), of ipsilateral or contralateral R2, in hypothyroid subjects as compared to controls. No statistical significant difference is demonstrated in latency of R1[20].

In our study latency of iR1 and cR2 is found to be significantly more after exposure to EMR emitted from mobile phone in right eye. Increased latency of iR1 indicates involvement of facial nerve and R2 indicates both facial and trigeminal nerves are involved. It is also interesting to note that in our previous study on recording of conduction velocity of ulnar nerve and median nerve after exposure to EMR emitted from mobile phone, conduction velocity of motor and sensory components of both these nerves were found to be decreased[6,7]. As abnormality of BR and direct response are well correlated with slowing of motor nerve conduction velocity of median nerve and median sensory nerve fibres[1,21,24]. While in the left eye, latency of iR2 increased non-significantly and latency of iR1 and Cr2 decreased significantly. Response of right eye is different from left eye. It may probably be due to the fact that right eye is exposed to mobile phone held near to right ear when on talking mode as right ear is found to be dominant ear[6]. Biological effects of MP exposure depend on duration of exposure, distance from source, tissues and species. In accordance with us, Movvahadi et al (2015) and others also reported significant alteration in visual

reaction time after 10 minutes exposure to MP[26,5]. Exact cause of alteration of BR by EMR emitted from mobile phone is not clear, may be the alteration in temperature, cerebral metabolism and demyelination cause changes in BR[27] . Many recent studies show that there occurs changes in neurotransmitters i.e., catecholamines, serotonin, acetylcholine concentration in the brain of animals after exposure to low intensities of EMR[28]. Noor et al in 2011 suggested that changes in amino acid neurotransmitter concentration may be the underline reason for reported adverse effects of using the mobile phone[29]. Moreover various evidences demonstrated that responses of CNS to EMR could be stress responses[30]. A possible mechanism of interaction of biological system and EMR is a process, which involves free radical formation(ROS) either by energy transfer or electron transfer reactions after exposure, which are highly cytotoxic leading to cell and tissue damage[31] . Thus ROS may be responsible for neurodegenerative effect due to 3G mobile phone[32].

Conclusion:

So, it is concluded that exposure to EMR emitted from mobile phone affects blink reflex. Probably it is the first study showing the effect of short term exposure of electromagnetic radiation emitted from mobile phone on cranial nerves through blink reflex. Furthur study is required on large number of subjects of both sexes on more cranial nerves by using more parameters.

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