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THE CHRONIC EXPOSURE OF ELECTROMAGNETIC WAVES EMITTED FROM MOBILE PHONE ALTERS AUTONOMIC FUNCTIONS OF HUMAN BODY

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ABSTRACT

Mobile phones (MP) are the most widely used instrument of present era. It works through electromagnetic (EM) waves. The antenna remains very close to the head which is prone to affect the brain and its functions. The present study was a case-control study designed to see the effect of EM radiation on the autonomic function of the human body by measuring Galvanic skin Response (GSR). The study conducted in PGIMS Rohtak, Haryana, INDIA. 100 male subjects of age 18-40 were selected, and divided into 2 groups Group I (50) not using MP and Group II (50) using MP for 2-5 years with a mean duration of 30 minutes/ day. Both the groups were exposed to MP radiation for 30 minutes. The pre exposure and post exposure GSR were measured and compared using non parametric tests. The acute exposure to mobile phone for 30 minutes did not cause a significant change in the GSR level but when the basal GSR level was compared in both the groups, it was quite high in the users group (1.137 ± 1.04) than the non users group (0.5491 ± 0.61).

KEYWORDS : Mobile phone, Sympathetic nervous system, Galvanic skin response

Mobile phone is one of the revolutionary products of the modern age. It is a two way radio device working through electromagnetic waves. From its introduction in 1973 in Europe by Motorola company, (History of mobile phone [online]) the device has gained so much popularity that now almost one third of the world population is accessible to it. Mobile phones have now become an essential part of daily living and all-round development. The mobile phones are the low power radio devices that transmit and receive radio frequency radiation through an antenna present close to the users' head. The transmission comes from a base station near by the vicinity of the user, which serves an area of definite diameter. This limited service area of a base station is termed as a "Cell". The term "cellular phone" is derived from it. For technical reasons the cells are hexagonal in shape (Michael M., 2000). Mobile phones and their base stations transmit and receive signals using electromagnetic waves (EMW). Frequencies between 30 kHz to 300 GHz are widely used for telecommunication, including broadcasting of radio and television and popularly called as the radiofrequency (RF) band (Stewart w editor. 2000). The radiation energy associated with these waves is directly proportional to their frequencies (Planck's law). The mobile telecommunication of the present era is mostly second generation GSM type which utilizes waves of 900-1800 MHz to carry voice information via small modulations of the wave frequency. The base station radiates the waves at a power of 60 W which are received by the hand set. Every communication channel has 8 time-slots which are transmitted in 576 μs. Together these 8 slots forms a frame. These frames repeat at a rate of 217 Hz. The frames transmitted are grouped into "multi frames" of 25 and every 26th frame is absent for technical reason. This results in an additional low frequency pulsing of signal at 8.34 Hz which is unaffected by call density. This arrangement make the hand sets also produce radiation of peak power of 2W. This radiation is transmitted to all the direction equally. In the present day handsets having energy saving discontinuous transmission mode (DTX), there is an even low frequency pulsing of 2 Hz which radiates when the user is listening but not speaking (Hyland G. J., 2000).

This new technology despite its acknowledged benefits has one common matter of concern i.e. whether increasing exposure to the electromagnetic fields generated during the use of this wireless communication could lead to health problems? The search is on, in the foot steps of other electromagnetic gadgets like RADAR, primarily concerned with its carcinogenic effects. Till date no satisfactory data has been established except that of Repacholi et al., 1997 who documented that the electromagnetic radiation may increase incidence of lymphoma in transgenic mice (Repacholi et al. 1997). Besides the carcinogenic effects, some neurological symptoms like sleep disturbances, memory problems, headaches, nausea, and dizziness have also been reported, (Harmann D.A. and Hossman K. A., 1997). Changes in the electroencephalographic activity,

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blood pressure, and interference to other sensitive electronic devices used in the medical practice like pace makers etc. have also been reported (Krause C. M. et al., 2000, Braune S. et al., 1998, Occhetta E. et al., 1999). Tantalizing findings in humans include a speeding up of reaction time during exposure, particularly during behavioral tasks calling for attention (Preece A. W. et al., 1999, Koivisto M. et al., 2000).

From the present knowledge, it is evident that the mobile phone exposure is affecting all most every system. But the current studies are not clear about the effect on the autonomic nervous system of human being. The present study is designed to measure the effect of mobile phone radiation on the sympathetic nervous system by measuring the Galvanic Skin Response.

Galvanic skin response (GSR), also known as electro dermal response (EDR), psycho galvanic reflex (PGR), or skin conductance response (SCR), is a method of measuring the electrical resistance of the skin i.e. the resistance faced by an electric current when passed through the skin. This resistance of skin is determined by the sweat produced by the sweat glands as sweat contains water and electrolyte which are better conductor of electricity, hence increase in sweat production decreases the resistance, the decrease resistance increases the current flow which can be recorded as increase in GSR and the opposite happens when there is a decrease in sweat production. These results have been repeatedly observed and verified in different experimental conditions e.g. sweat producing drugs increase the GSR and the sweat depressing drugs decrease the GSR. As sweat glands are innervated by the sympathetic cholinergic fibers, GSR indirectly measures the continuous sympathetic activity. There is a relationship between sympathetic activity and emotional arousal i.e. increase in cortical arousal increases the sympathetic activity, therefore GSR can be considered as a measure of emotional arousal. The GSR is highly sensitive to emotions in some people, though type of emotion can not be differentiated, as fear, anger, startle response, orienting response and sexual feelings are all among the emotions which may produce similar GSR responses. Easily measured and relatively reliable, GSR has been used as an index for those who need some measurable parameter of a person's internal "state" (Conesa J., 1995 GSR or Galvanic Skin Response [online]).

MATERIALS AND METHODS

The present study was conducted in the cardio vascular laboratory of Department of Physiology, Pt.B.D. Sharma PGIMS Rohtak. Healthy male subjects of the age group 18 40 years were selected from the staff members, medical students and healthy attendants accompanying the patients to the institute. The study group comprised of 50 Healthy male subjects not using mobile phone(group I), the control group and 50 Healthy male subjects using mobile phone(group II), the case group. The subjects were using the phone for at least 2 years (ranges from 2-5 Years). All the subjects were specifically questioned about the history of any major illness or intake of any kind of drug since last 1 year. Patients with the history of any cardiovascular disease, other diseases affecting autonomic system like diabetes mellitus, or any psychiatric diseases were excluded from the study. Information pertaining to their age, sex, height, weight was recorded in a printed patient Performa. Body Mass Index was calculated from Dubois Body Surface chart. Vitals like pulse, blood pressure were also recorded in the same Performa. Finally all the subjects were exposed to mobile phone radiation and the Galvanic Skin Resistance was recorded.

Apparatus Used

The apparatus used, was RMS Digitized polygraph, POLYRITE D system Supplied by RMS India Pvt. Ltd, Chandigarh. This machine records Galvanic skin resistance along with other parameters like electrocardiography, respiration etc. simultaneously by separate channels and separate electrodes. Individual customization of the data can be done after acquiring. Data was stored in the hard disk and were analyzed offline. Finally the printed report was generated for future reference.

To make the results reliable and interpretable the following recommendations are followed,

Sampling rate - 256 Hz.

Filters - High filter - 99 Hz Low filter - 0.1 Hz.

Sensitivity- A moderate high sensitivity is kept i.e. 50 μV.

Recording Protocol

The aim of the experiment and the whole procedure was explained in detail to each and every subject in his own language to allay any fear or apprehension. All the experiments were conducted in a particular period of time (from 10 am to 1 p m) to avoid any diurnal variation. The subjects were asked to take rest for 5 minutes to avoid any anxiety and the effect of exercise like walking to the laboratory.After the general examination, the subject was asked to lie down on a couch in front of the POLYRITE D system. For measuring GSR, 2 hand held Copper lined electrodes were tied in thumb and the index finger on the palmer aspect of distal digit of right hand after applying the conduction jelly. Then the basal recording of G.S.R was done for 5 minutes. The subject then exposed to electromagnetic radiation by listening to a mobile phone which was held near to its ear in hand held position for a period of 30 minutes. Mobile phone used was of 1,800 MHz frequency band GSM type, model Panasonic GD 75. The highest Specific Absorption Rate (SAR) for this mobile phone is 0.669 Watt/Kg averaged over 10 gm of tissue. The phone was kept on through out the exposure period to avoid high exposure of the radiation during logging into the network. In the whole duration of exposure only non-exciting things were made listen to the subject to avoid stress, due to speech and any autonomic alteration by activating the emotional component of the subject. After 30 minutes of mobile phone exposure GSR was again recorded for a period of 5 minutes. The average amplitude of GSR calculated manually for the selected period of 5 minutes both before and after exposure.

For interpretation of the result then the data set of each group was subdivided into two sub groups

Pre - before exposure

Post - after exposure i.e.

Group I pre- Non user group before exposure

Group I post - Nonuser group after exposure

Group II pre - User group before exposure

Group II post - User group after exposure.

Data Analysis

Statistical analysis was conducted with SPSS for windows version 10.0. Baseline information in frequency measure calculated and found out that the data were positively skewed. Hence both the groups were compared by applying non parametric test like wilkoxon signed rank test for intra group comparison and Man Whitney U test for inter group comparison. The alpha level was set at 0.05 for these tests.

RESULT

Out of the 100 subjects (50 mobile phone users & 50 mobile phone non users) 2 subjects, one from each group were excluded during data analysis because the result was erroneous probably due to defective data recording.

In the mobile phone non user group, when the comparison was done between pre exposure GSR values and post exposure values we found no significant difference though the mean GSR value decreases in post exposure (0.453 ± 0.6) of mobile phone than pre exposure (0.549 ± 0.61) one, (table 1).

In the mobile phone user group when the same values were compared there was no statistical significant decrease in post exposure value (0.954 ± 1.02), than the before exposure (1.137 ± 1.04) (table 1). Both the above findings show that there is a minimal decrease in the sympathetic activity after acute exposure of the mobile phone radiation as shown by the mean value.

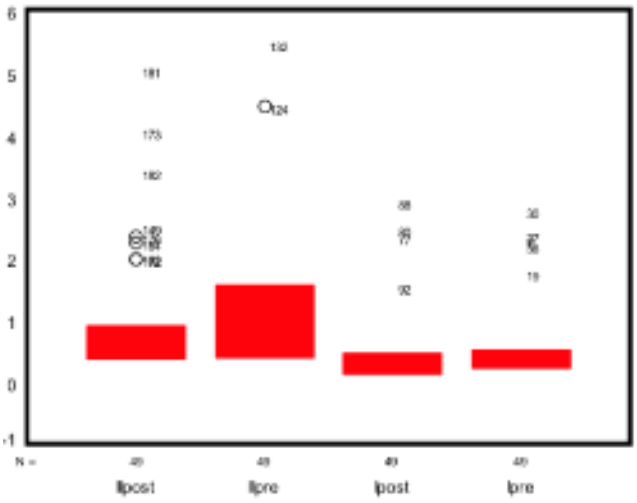

Figure I : Showing Skewedness of the Data

Figure I: shows the skewedness of the data as mean is less than the standard deviation for which non parametric tests were applied for analysis.

Table I : Showing Comparison Pre Exposure and Post Exposure Values in Both the Groups

	Mean	Standard Deviation	Z value	P value
I pre	.549152	.617420		
I post	.453882	.602853	- 1.686	NS
II pre	1.137567	1.048169		
II post	.954246	1.023748	- 3.169	NS
I pre	.549152	.617420	- 4.246	<0.01 *
II pre	1.137567	1.048169		
I post	.453882	.602853	- 4.308	<0.01 *
II post	.954246	1.023748		

* indicates statistically signifinant

Table I: shows no significant change of GSR in the case of acute exposure but chronic exposure causes a definite increase in GSR.

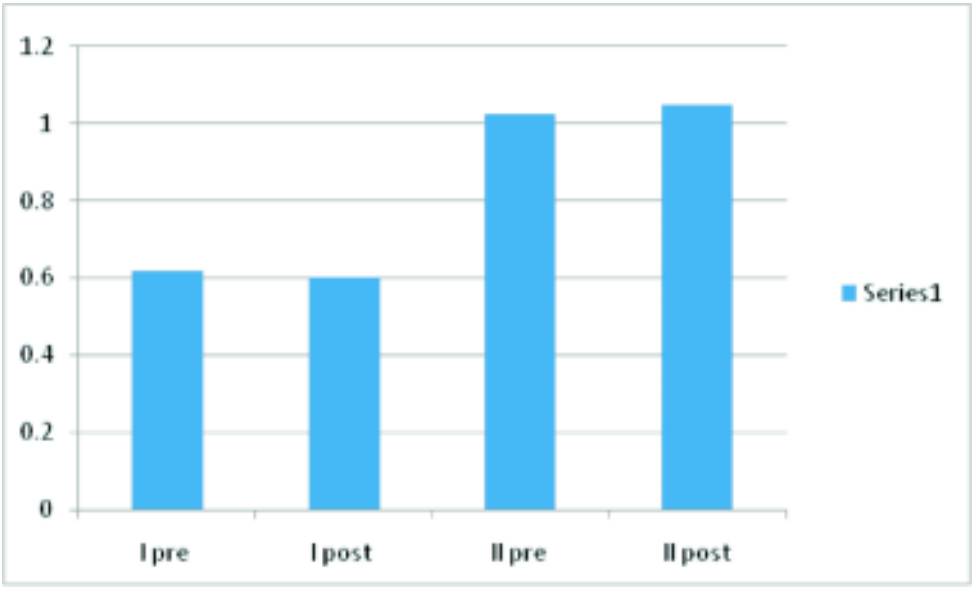

Figure 2 : Showing Comparison of GSR Values in Not Exposed and Exposed Groups

Figure 2: Shows that though acute exposure does not show any autonomic changes but in the group using mobile phones for years has definitely have increased sympathetic activity than the non exposed group

Further the values of GSR were compared between the two groups before the exposure. We found that there was a significant increase in user group (1.137 ± 1.04) than from the non user group (5.491 ± 0.61), (Table-1). This indicates there is major change in sympathetic activity towards a higher direction in the regular mobile phone users.

Finally the GSR values of both the groups were compared after exposure which show a significant increase in the post exposure value in user groups (0.954 ± 1.02) than the non user group (.453882 ± .602853) (Table-1).

DISCUSSION

Previously it was thought that the main adverse effect of this EM radiation exposure is due to its heating effect produced in its vicinity. But now it is confirmed that the present day mobile phones producing 0.2 w/kg energy is unable to generate a temperature more than 0.1 ^{0}C. This amount of energy is quite low to produce any molecular

damage in the living tissue.6

Sadchikova and Orlova (1964) from USSR studied the chronic effects of EM radiation exposure and reported that there is some non thermal effect of this EMF beside thermal effect (Sadchikova MN, Orlova AA. 1964.). This was again supported by association of symptoms like head ache, sleep disturbances, short term memory impairment, increase of seizure frequency in some sensitive persons. These studies predict that there must be some non thermal effect of the EMF on the living tissue that is generated from the mobile phones which can affect almost every system of living organisms.

The GSR (amplitude) measured in µMho represents the resistance to the current flow which is a measure of sweating. The sweating in fact depends on the sympathetic activity and hence it is an indirect measurement of peripheral sympathetic activity (Daniel JP, George EM, Edwin TW. 1963).

Previous experiments have shown that the sweat inhibiting substances like methanthelin bromide, propanthelin bromide, or atropine were directly correlated with a lower GSR level when compared with a placebo immaterial of the fact that whether the drug acts directly on the sweat gland or it is due to anti cholinergic effect (Perry D.J. 1955, Perry D.J, Mount G.E. 1955, Perry D.J et al 1957, Perry D.J, Mount G.E. 1959). Keeping the fact in the mind in the present study where the control group (i.e. the mobile phone non user group) has a less GSR value than the case group (i.e. mobile phone user group) it can be well predicted that the chronic use of mobile phone is the reason for the high basal sympathetic tone in the individuals as both the groups are similar in all other aspects like age, sex, BMI etc. Not only the basal sympathetic tone but also the acute exposure of the radiation fails to elicit a significant sympathetic activity in both the group (Though the mean value decreases). Though no direct literature is available on the effect of mobile phone radiation on GSR but the finding is not in confirmation of the finding of the other researchers who found the acute exposure of the mobile phone radiation causes an increase in sympathetic activity in the form of increase in heart rate, blood pressure etc.

One attempt to explain the result of the acute exposure in the GSR value by mobile phone radiation is the prediction by Agnese et al. (1962) who reported from the children suffering from pancreatic cholera that GSR primarily depends on the change in the electrolyte composition of the sweat rather than the volume of the GSR produced by the sympathetic activity. Again Perry et al shown that there is a wide variation of basal level of the GSR in the individuals which may also be responsible for this result (Agnese PAD et al 1953).

CONCLUSION

Though the acute exposure of mobile phone radiation for a short period does not elicit any autonomic dysfunction measured through GSR but it is clear that the chronic use of the same increases the basal sympathetic tone which may be hazardous. For more precise decision larger study group with long term recording is required.

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