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EFFECT OF LONG DURATION EXPOSURE OF MOBILE PHONES ON HEART RATE VARIABILITY

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ABSTRACT

Mobile phones (MP) are now used by approximately 63% of world population. It works through non ionizing electromagnetic (EM) waves of medium range proposing health issues. 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 time domain functions of Heart Rate Variability (HRV). 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 HRV 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 HRV components level but when the basal HRV components were compared in both the groups, those were quite high in the users group than the non user group like SDNN user (70.993 ± 96.69),SDNN non user (44.46 ± 16.3), RMSSDuser group (36.90928 ± 19.88091) RMSSD non user group (29.36568 ± 13.0391).NN50in non-users (32.06 ± 33.09196) NN50 in users:(53.9 ± 47.32012) pNN50: in non-users (12.632 ± 12.81879) pNN50: in users (20.51 ± 19.72159). Though the immediate exposure to the mobile phone radiation does not cause a significant change in the autonomic system but the long exposure no doubt alters autonomic system.

KEYWORDS: Mobile Phone, Sympathetic Nervous System, Galvanic Skin Response

In the present age of extensive industrialization, the rapid development of technology has gifted us many a gadgets like mobile phone, computer, ipod etc. Out of which mobile phone is one of the revolutionary products. It is a two way radio device working through electro magnetic waves. It was first introduced in 1973 in Europe by Motorola company.[1]Though originally devised as a communication device, but its gradual evolution now made it a multi task device used for various purposes e.g. playing music, keeping time, calculating, playing animated games, taking photographs as camera etc.

This new technology despite their 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.Similar to other electromagnetic gadgets like RADAR, the prime concern is on its carcinogenic property. Till date no satisfactory fact was established except that of Repacholi et al. (1997) who documented electromagnetic radiation may increase incidence of lymphoma in transgenic mice. Not only cancer, but some neurologic symptoms like sleep disturbance, memory problems, headaches, nausea, and dizziness are also reported.[3] Changes in the electroencephalographic activity, blood pressure, Interference to other sensitive electronic devices used in the medical practice like pace makers etc. have also been reported.[4-6] Tantalizing findings in humans include a speeding up of reaction time during exposure, particularly during behavioral tasks calling for attention.

The present study has been designed to investigation Heart rate variability (HRV) to assess the autonomic function. HRV analysis provides a quantitative marker of the autonomic nervous system (ANS) because the regulation mechanisms of HRV originate from the sympathetic and parasympathetic nervous systems.[9]

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 in the age group of 18 – 40 years were selected from the staff members, medical students and healthy attendants accompanying the patients to the institute. They were divided into 2 groups; GROUP I: 50 Healthy subjects not using mobile phone.GROUP II:50 Healthy subjects familiar and using mobile phone. The subjects are using the phone for at least for 2 years (ranges from 2-5 Years). Selection criteria includes:1. No history of major illness in the

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previous one year.2. Normal clinical examination. 3. Not taking any drug for any ailments in last one month.5. Willingness to undergo the procedure.Exclusion criteria includes Presence of cardiac disease, Presence of chronic vascular disease, Presence of any mental abnormalities.Study was carried out between 10 am to 1 pm, to avoid diurnal variation.Both the groups were given the mobile phone exposure for 30 minutes. The pre exposure and the post exposure recordings were taken and compared statistically.

The apparatus used, was RMS Digitized polygraph, POLYRITE D system Supplied by RMS India Pvt. Ltd, Chandigarh. This machine, records Electrocardiography by separate channels and separate electrodes. Individual customization of the data was done after acquiring. Since ectopic beats, arrhythmic events, noise may also alter the short term recordings as well as the spectrum results hence the careful selection of particular duration of recording has been done manually. The data set of mobile phone non user (group I) and mobile phone user (group II) were compared by student's t-test and the variables in each group before exposure (IA or IIA) and after exposure (IB or IIB) were compared by applying paired t-test.p value <0.05 was considered as significant (S).

OBSERVATION AND RESULTS

Result demonstrates

Table 1: Anthropometric parameters of mobile phone non user (Group I) and user (Group II)

Parameter	Group I Mean ± SD	Group II Mean ± SD	P Value
Age (years)	28.12±5.6	26.3±6.64	NS
Weight (Kg)	70.1 ± 8.69	66.72 ± 10.17	NS
Height (meter)	1.68 ± .062	1.68 ± 0.07	NS
BMI (kg/m^2)	24.621 ± 2.66	23.525 ± 3.28	NS

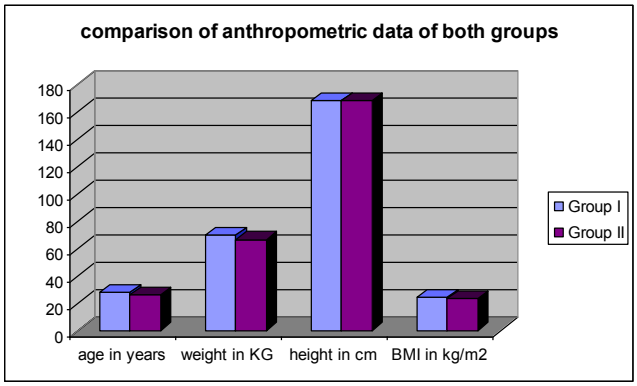


Table 2: Comparison of heart rate of non user groups before (I pre) and after (I post) exposure

Parameter	Group I pre Mean ± SD	Group I post Mean ± SD	P Value
Maximum HR	91.31 ± 12.64	91 ± 13.10	NS
Minimum HR	67.04 ± 9.23	66.14 ± 9.81	NS
Mean HR	77.82 ± 11.12	77.4 ± 11.31	NS

None of the three components shows any significant difference.

Table 3: Time domain variables of Non user groups before (I pre) and after (I post) exposure

Parameter	Group I pre Mean ± SD	Group I post Mean ± SD	P Value
SDNN (ms)	43.503 ± 13.82	44.465 ± 16.37	NS
RMSSD	29.365 ± 13.03	29.780 ± 13.27	NS
NN50	32.06 ± 33.09	36.22 ± 33.98	NS
pNN50 (%)	12.632 ± 12.81	12.726 ± 12.71	NS

None of the parameter shows any significant difference before and after the exposure.

Table 4: Heart rate of user groups before (II pre) and after (II post) exposure

Parameter	Group II pre Mean ± SD	Group II post Mean ± SD	P Value
Maximum HR	89.88 ± 14.59	90.78 ± 10.55	NS
Minimum HR	64.08 ± 10.55	62.84 ± 9.89	.03
Mean HR	74.4 ± 12.09	74.12 ± 10.18	NS

Minimum heart rate shows a significant decrease statistically after exposure.

Table 5: Time domain variables User groups before (II pre) and after (II post) exposure

Parameter	Group II pre Mean ± SD	Group II post Mean ± SD	P Value
SDNN (ms)	51.544 ± 24.33	70.993 ± 96.69	NS
RMSSD	36.909 ± 19.88	38.497 ± 18.67	NS
NN50	53.9 ± 47.32	52.94 ± 45.19	NS
pNN50 (%)	20.51 ± 19.72	21.262 ± 18.79	NS

None of the parameters shows any significant difference.

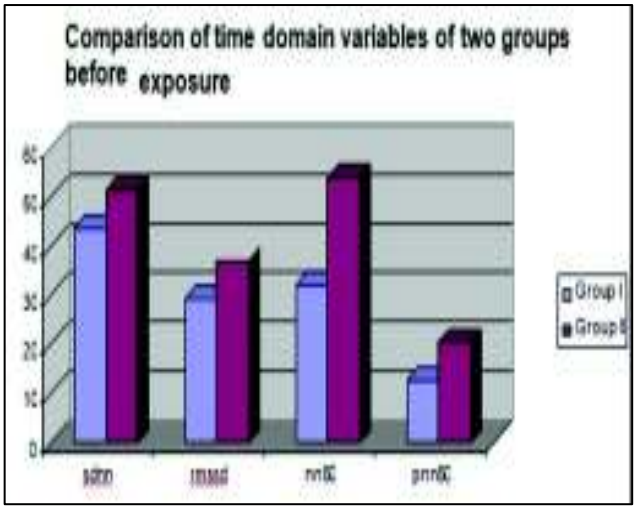
Table 6: Heart rate of non user (I pre) and user groups (II pre)

Parameter	Group I pre Mean ± SD	Group II pre Mean ± SD	P Value
max HR	91.32 ± 12.65	89.88 ± 14.59	NS
min HR	67.04 ± 9.23	64.08 ± 10.55	NS
mean HR	77.82 ± 11.12	74.4 ± 12.09	NS

The comparison of heart rate, calculated from RR interval of ECG recording of 5 minutes duration i.e. maximum, minimum, and mean heart rate show insignificant difference between the two groups with P Value (>0.05).

Table 7: Before exposure comparison of Time Domain variables of HRV in Non user (I pre) and user groups (II pre)

Parameter	Group I pre Mean ± SD	Group II pre Mean ± SD	P Value
SDNN (ms)	43.503 ± 13.82	51.544 ± 24.33	0.04
RMSSD	29.365 ± 13.03	36.909 ± 19.88	0.02
NN50	32.067 ± 33.09	53.9 ± 47.32	0.008
pNN50 (%)	12.632 ± 12.81	20.51 ± 19.72	0.008



The above table shows the comparison of time domain variables of HRV in two groups before the mobile phone exposure. The user group shows significant increase in SDNN and RMSSD in two groups. Significant increase is also demonstrated in pNN50 with p value<0.01.

In comparison of both the groups (I and II) before exposure Though the heart rate do not show any difference but the time domain variables of HRV show a significant increase in all the components like SDNN,RMSSD, NN50, and PNN50.

DISCUSSION

With the development of technology, more and more products of utility are developing for making the life easy. Most of these products are working by utilizing the EM Waves, for which the health hazards due to EMF exposure is becoming one of the important areas of research. Unlike the time of 1970 when the occupational exposure like RADAR station emission was the prime area of concern, now in the present era the non occupational exposure is claiming a major issue of discussion that is coming from daily use substances like Tele Vision, Micro Ovens, and Mobile Phones etc. Out of this Mobile phone exposure is getting more importance as it produces EM Waves very close to the head. These waves penetrate the scalp and can alter the electrical activities of brain. Previously it was thought that the main adverse effect of this EMF 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. Sadchikova and Orlova (1964) from USSR

studied the chronic effects of EMF exposure and reported that there is some non thermal effect of this EMF beside thermal effect.[11] 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.

Parazzini et al. (2006) observed there was some definite relation between HRV parameters like SDNN and LF with the posture. So to avoid the effect of posture all the studies were carried out in supine position only.[12]

Effect on Heart Rate

In the non user group (Group I) the heart rate does not show any change after the acute exposure of the mobile phone for 30 minutes. In the mobile user group (Group II) the minimum heart rate shows a decrease from pre exposure value of (64.08 ± 10.55) to post exposure value of (62.84 ± 9.89). This result predicts a bradycardia which indicates a parasympathetic activation after the mobile exposure.In both the groups (Group I and II) when the heart rate compared before and after the mobile phone exposure then no significant difference was found between them.

Effect on Time Domain Variables of HRV

SDNN (Standard Deviation of Normal to Normal RR Interval)

The current study predicted that in the mobile phone non user group (group I) when the time domain variables like SDNN compared before and after the exposure then there was no significant difference between both the values. The same result was obtained when in the mobile user group (group II) SDNN was compared before and after the exposure. The result supports the finding of Parazzini et al. and Thazudin. On the other hand, when the SDNN of non user (group I) and user groups (group II) were compared before the exposure of mobile phone then it was found that the mobile user group have a significant high SDNN value (51.54442 ± 24.3316) than the non user group (43.50302 ± 13.82794),SDNN is the most important component of time domain variable. This result supports the study of Andrzejak et al.[14]After the exposure of the mobile phone for thirty minutes when both the groups (Group I and II) were compared then it was found that the SDNN has a low value in the mobile non user group (44.46 ± 16.3) than that of the mobile user group (70.993 ± 96.69). This difference in the user group is due to the increase in basal level SDNN in the users. This indicates there must be some alteration in the autonomic modulation.

RMSSD (Root Mean Square of Standard Deviation of Adjacent RR Interval Difference)

It also shows the same result as that as SDNN. In the non user group (Group I) it does not shows any change in the value before and after the exposure of mobile phone. In the user group (Group II) also the change in the value is not significant before and after the exposure of mobile phone. When both the group (Group I and II) compared before exposure it shows a significant high value in user group (36.90928 ± 19.88091) than in the non user group (29.36568 ± 13.0391). Like SDNN it is also a marker of parasympathetic activity. It is a measure of short term components affecting the HRV, unlike SDNN which estimates both short term and long term effect. RMSSD is preferred over other time domain variables like NN50 and pNN50 because of its better statistical property. Ronald et al. (2003) concluded in the preterm infants that RMSSD is even a better parameter than that of SDNN in measuring the parasympathetic activity who found that the decrease is well correlated with the sudden infant death. After exposure when both the groups (Group I and II) were compared then RMSSD also shows a low value in the non user group (29.78 ± 13.27) than in the user group (38.497 ± 18.67). This is also due to the increase basal values in both the groups.

NN50 (The Number of RR Interval Having More Than 50ms Duration) and pNN50 (Proportion of Total RR Interval Having Duration More Than 50ms)

These also have the same trend as that of SDNN and RMSSD. In the non user(Group I) and user group (Group II) when the values were compared before and after exposure of the mobile phone then there was no significant change was found. In both the groups (Group I and II) when the values were compared before exposure then in the mobile non users there was a significant low value (32.06 ± 33.09196, 12.632 ± 12.81879) than that of mobile user group (NN50: 53.9 ± 47.32012, pNN50: 20.51 ± 19.72159).Kleiger (1987) reported the parameters like pNN50 and RMSSD are well correlated with the high frequency variations.This was supported by Stewart et al. (2006) who documented in subjects exposed to high ambient heat the HF variable of frequency domain decreases which is well correlated with the decrease of the RMSSD and pNN50. [17]Again Kleiger et al. documented

that the parameters like RMSSD, NN50 and pNN50 are the markers of the parasympathetic activity of the heart and are all well co-related with the SDNN. NN50 and pNN50 also shows a statistically significant low value in non users (NN50: - 36.22 ± 33.98, pNN50: -12.726 ± 12.71) than the user group (NN50: - 52.94 ± 45.19, pNN50: - 21.262 ± 18.79), after exposure of the mobile phone.

CONCLUSION

Our findings indicate that the acute exposure of the mobile phone radiation causes a change in autonomic modulation of cardiovascular system to some extent but it is well demonstrated in people who are exposed to the radiation or in the persons who are using the mobile phone from quite some time. There is no such significant effect in persons unexposed to mobile phone. The acute exposure of mobile phone shows increase in time domain variables of HRV. To express the statements strongly and to predict the alteration of the variables in one definite direction more duration of mobile phone exposure, large sample size longitudinal study is required.

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