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A Pilot Study on Long Term Effects of Mobile Phone Usage on Heart Rate Variability in Healthy Young Adult Males

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ABSTRACT

Introduction and Objectives: The electromagnetic fields which are emitted by cellular telephones may influence the autonomic tone which modifies the functioning of the circulatory system. The present research work was taken up to study the long term impact of mobile phone usage on the heart rate variability (HRV) in healthy, young, adult males.

Methods: A total of 37 healthy, volunteered males (18 -24 years) were included in the study and they were grouped in to mobile users who had been using the mobile phones for more than one year (n=21) and non-mobile users (n=16). The HRV was analyzed both by the time domain and the frequency domain methods during normal breathing. Statistical analysis was done by using the Students unpaired t-test. A two tailed p value less than 0.05 was considered to be significant. The present study was completed in two months.

Results: In the time domain analysis, the HRV showed no statistically significant difference in between the two groups. But in the frequency domain analysis, the total power (TP), the very low density frequency (VLF) power and the low frequency (LF) power were found to be statistically significantly high in the mobile users. The high frequency normalized unit (HF nu) was low and the LF normalized unit (LF nu) and the LF: HF ratio were high in the mobile users.

Conclusion: The present study showed that the mobile users had a higher sympathetic tone and a lower parasympathetic tone as compared to the mobile non users.

Key Words: Heart rate Variability, Time domain method, Frequency domain method, Mobile phone users and non-users

INTRODUCTION

The radiofrequency (RF) electromagnetic fields (EMF) of the mobile communication systems are widespread in the living environment. The potential health risk of the electromagnetic fields which are emitted by mobile phones (MP) is of considerable public interest. In the recent years, mobile phone subscriptions have reached the symbolic threshold of five billion and people have decided that the benefits outweigh any risks to their health. Mobile phones are low power radio devices that transmit and receive radio frequency radiation which might induce or promote cancer, and the symptoms which are associated with their use include sleep disturbances, memory problems, headaches, nausea, dizziness and changes in the electroencephalographic activity [1,2, 3]. Recent studies have shown that the decreased fluctuation of the R-R intervals implicates an increased risk of arrhythmic events and an increased mortality rate [4, 5]. The time and frequency domain measures of the HRV have provided prognostic information and they have also made it possible to perform non-invasive studies on the significance of the changes in the regulation of heart rate behaviour. Electromagnetic fields which are emitted by cellular phones interfere with the work of cardiac pacemakers and other implantable medical devices [6, 7]. It was shown that the occupational exposition to EMF could cause fluctuations in the heart rate and the heart rate variability [8,9]. Previous studies on the acute usage of mobile phones have shown controversial results on the cardiovascular parameters [10,11,12,13]. There is no sufficient data which has shown the long term effects of mobile phone usage on the heart rate variability. Hence, the present research work was taken up to study the impact of mobile phone usage on the heart rate variability in healthy, young, adult males.

MATERIALS AND METHODS

The present study was conducted at the Kasturba Medical College, Center for Basic Sciences, Bejai, Mangalore. A total of 40 healthy, male volunteers between the ages of 18-24 years were included in the study. They were grouped into twenty one mobile users and sixteen non mobile-users. The mobile users had been using mobile phones for more than 2 hours in a week, during a period of more than 1 year. The non-mobile users had not been using mobile phones. All the participants were healthy and none of them were on any pharmacological treatment. The following exclusion criteria were accepted for the investigation: presence of any serious cardiovascular disease, including arterial hypertension and metabolic and neurological disorders that could influence the heart rate variability and serious arrhythmias. Three subjects were excluded, based on the exclusion criteria. A written informed consent was obtained from all the students who took part in the study. The study was approved by the institutional ethical committee and the procedures were followed in accordance with the institutional ethical standards. All the subjects were asked to abstain from consuming caffeinated beverages and undertaking excessive physical activity, including gymnastics, for 12 hrs preceding the data collection. They were also requested not to eat and drink on the morning of the experiment and to not take a shower. The students were fully habituated to the equipment, the protocols and the experimenters. Our investigation was performed in a semi-darkened, temperature-controlled, quiet laboratory which was at room temperature (21°C). Before the experiment, the participants rested in a laboratory room in a sitting posture for about 20 min. The records were taken between 09:00AM–10.00 AM in the morning under similar conditions (the same place of the experiment and the same sitting position). The general physical examination including height, body weight, blood pressure, pulse rate, respiratory rate and the complete systemic examination was done. The subjects were screened to exclude any morbid state which could influence the autonomic response.

The autonomic activity was assessed by recording the electro cardiogram (ECG) and by measuring the R-R intervals and calculating the HRV by using a software which quantified the autonomic drive to the myocardium. The ECG was recorded from the limb lead II from all the subjects by using a BPL ECG machine and the analogue output from the machine was digitized by using an A/D converter from National Instruments, Bangalore. The HRV was analyzed by using the "HRV soft 1.1 Version" software package (built by using the LabView software from Texas Instruments, USA) which was provided by the All India Institute of Medical Sciences (AIIMS), New Delhi. The ECG was recorded from all the subjects while they were in a supine position, fully relaxed and breathing normally for a period of five minutes, which gave the "Short term HRV".

The HRV was analyzed both by the time domain and the frequency domain methods during normal breathing. In the time domain analysis, the mean value of the R-R interval; RMSSD – root of the mean of the squared successive R-R interval differences; NN50 – the number of R-R interval differences which were equal to or more than 50 milliseconds; and pNN50 – the percentage of NN50 were analyzed. In the frequency domain analysis, the R-R series were transformed to the frequency domain and the spectral power was determined. Further, in accordance with the task force of the European Society of Cardiology and the North American Society of Pacing Electrophysiology [14], we calculated TP, VLF, LF, HF, LFnu, HF nu and the LF:HF ratio.

Statistics: Statistical analysis was performed by using the "STATISTICAPL 6.0" package (StatSoft Poland). The data were expressed as means and standard deviations. The analysis was done by using the Students unpaired t test. A p-value of <0.05 was considered as statistically significant.

RESULTS

The demographic characteristics of the subjects, like age, basal heart rate, weight, body mass index and the blood pressure of the mobile users and the mobile non-users are represented in [Table/Fig-1]. There was no statistically significant difference in the demographic characteristics between the mobile users and the mobile non-users. Further, the analysis of the HRV by the time domain method [Table/Fig-2] showed no statistically significant difference in any of the variables between the two groups. Whereas, in the frequency domain analysis of the HRV, the TP, the VLF power and the LF power were statistically significantly high in the mobile users as compared to the mobile non-user groups. The values of LF nu and the LF: HF ratio were high and HF nu was low in the mobile users as compared to the mobile non-user groups, but this difference did not reach up to the statistically significant level [Table/Fig-3].

Parameter	Mobile Users (Mean ± SD)	Mobile non users (Mean± SD)	P-value
Age (years)	20.41 ± 2	21.63 ±3	0.15
Heart rate(beats/min)	71.58 ± 8	76.00 ± 15	0.26
Weight (kg)	66.81 ± 7	64.08 ± 6	0.22
Body mass index (kg/m^2)	23.06 ± 3	22.64 ± 3	0.67
Blood pressure (mmHg)			
Systolic BP	119.43 ± 5	120.23 ± 4	0.60
Diastolic BP	78.65 ± 4	77.04 ± 3	0.19

[Table/Fig-1]: Demographic characteristics of Mobile users (n = 21) and Mobile non users(n=16).
n = Number of subjects in the group

Parameters	Mobile Users (mean ± SD)	Mobile non users (mean ± SD)	P value
Mean R-R(ms)	841.41 ± 88	829.66 ± 98	0.70
RMSSD (ms)	42.37 ± 16	37.13 ±22	0.40
NN50 count	61.17 ± 44	56.88 ± 66	0.81
pNN50 %	17.82 ± 14	18.06 ± 11	0.95

[Table/Fig-2]: Comparison of time domain measures of heart rate variability between Mobile users and Mobile non usersduring normal breathing.

DISCUSSION

Mobile phones are being widely used, especially by young people. It is possible that the electromagnetic fields (EMFs) which are generated during the use of mobile phones may have an influence on the autonomic nervous system (ANS) and hence, on the heart rate variability. The heart rate variability is the simplest and most widely performed measure of the autonomic function, which signifies the sensitive, specific and the reproducible indirect measure of the autonomic activity. Researchers have examined the effects of the radio frequency radiation on the autonomic nervous system, as was measured by its impact on the cardiovascular system. The literature lacks data on the long term effects of mobile phone usage on the heart rate variability. Hence, the present work signifies the impact of long term mobile phone usage on the heart rate variability.

Previous studies have shown that the age, weight, body mass index and the blood pressure were the major factors that were known to affect the HRV [15-18]. However, in the present study, the demographic characteristics were well balanced and they did not differ significantly between the mobile users and the mobile non users. The time domain analysis of the HRV did not show any statistically significant results in the present study. Further, in the

Parameters	Mobile Users (mean ± SD)	Mobile non users (mean± SD)	P value
Total Power(ms^2)	3406.98 ± 2061	1965.46 ± 1316	0.01*
VLF Power(ms^2)	1286.87 ± 1029	647.98 ± 507	0.02*
LF Power (ms^2)	1133.82 ± 770	568.53 ± 472	0.01*
HF Power (ms^2)	986.29 ± 814	748.94 ± 680	0.35
LF Power (nu)	55.46 ± 16	46.39 ± 20	0.13
HF Power (nu)	44.53 ± 16	53.60 ± 20	0.13
LF:HF ratio	1.52 ± 0.84	1.28 ± 0.96	0.42

[Table/Fig-3]: Comparison of frequency domain measures of heart rate variability between Mobile users and Mobile non users during normal breathing (*P<0.05 denotes statistically significant).

frequency domain analysis, the total power, the VLF power and the LF power were found to be statistically significantly high in the mobile users as compared to the mobile non-user groups. The values of LF nu and the LF: HF ratio were high and HF nu was low in the mobile users as compared to the mobile non-user groups, but this difference did not reach up to the statistically significant level. It is now known that among the prominent frequency bands in the HRV frequency spectra, the high frequency (HF) component is attributed to the para-sympathetic influences on the heart and that the low frequency (LF) component is due to both the para-sympathetic nervous system (PNS) and the sympathetic nervous system (SNS) activities [19, 20]. This showed that mobile users had a higher sympathetic tone and a lower para-sympathetic tone as compared to the mobile non users. Studies on the usage of mobile phones have showed controversial results. Wilen et al., [21] found an increased heart rate variability and a very low frequency power during the night time in RF plastic sealer operators. They postulated that this could be due to an adaptation of the thermoregulatory system and the cardiac autonomic modulation to a long-term, low-level thermal exposure. Parazzini et al. [22], found no effect on the main outcome of the R-R interval on the electrocardiogram. The effect of the electromagnetic field which was emitted by mobile phones on the heart rate and the heart rate variability in young adults proved that the radio frequency fields which were emitted by cellular phones did not cause observable effects on the regulation of the heart rate [23]. Mann et al., [24] did not find any effect on the heart rate in young men who were exposed to 900 MHz of radiation. Nam et al., [25] and Barkeret al., [26] did not find any cardiovascular changes after RFR exposure from mobile phones.

Regarding the widespread use of mobile phones, closer attention should be paid to the young age group of people who use mobile phones for a long time and who are frequently exposed to electromagnetic fields. The results of our investigation suggest that the long term use of mobile phones might exert a noticeable effect on the autonomic balance and that it might progressively cause a deterious effect on the HRV, i.e. lack of a typical decrease in the parasympathetic activity, with the domination of the sympathetic system. Further, our study provides a supportiveevidence that the excessive use of mobile phones, in the long term, might provoke negative health effects. The detection of a sympathovagal imbalance at an early age due to the continuous usage of mobile phones and necessary life style modifications could decrease the incidence of cardiovascular diseases. But a limitation of our study is that, it was done in a small population and the randomization of the study population was not done. Hence, such studies have to be conducted in a larger population, with randomization, to confirm our results.

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