
Effect of Radiofrequency Radiation Emitted by a Mobile Phone on Human Cardiovascular System

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ABSTRACT

The mobile phone is now become part and parcel of everyday life. Mobile phone (MP) is a low powered, single channel, two ways radio. It emits radio frequencies (RF) radiation to transmit information to the base station. RF radiation can cause harmful effects on physiological systems on the human body. The present study was aimed to study the effects of radio frequency (RF) emitted from mobile phones on cardiovascular system of human body. The study was conducted on 10 young university male students having age range of 21- 23years. The heart rate, blood pressure and ECG wave characteristic were recorded by the BIOPAC lab system in sitting posture during ringing period of mobile phone (RF radiation- 900MHz) by placing mobile phone at three different positions, viz, mobile in shirt pocket, mobile in trouser pocket and mobile in the hand. The heart rate was found to have a significant difference ($p < 0.001$) between control condition and during the ringing of the mobile phone placed at shirt pocket. It was found that the systolic blood pressure was significantly higher ($p < 0.05$) during ringing of mobile phone than that of controlled condition; the significant difference was noted only when phone was placed in the trousers pocket. However, no significant difference was observed in diastolic pressure between ringing and no-ringing conditions of the mobile phone. From the ECG analysis it was noted that all the parameters of ECG, e.g., P-wave, QRS complex, T-wave, PR interval and RR interval, showed no significant change due to ringing of mobile phone. It was concluded that the RF emitted from mobile phone had some effects on cardiovascular system.

Key words: Radio frequency, mobile phone, Heart rate, ECG, blood pressure

INTRODUCTION

A mobile phone (MP) is a low powered, single channel, two ways radio. It allows users a wider opportunity to communicate by a principle call frequency reuse. Use of mobile phone (MP) has become a very common phenomenon all over the globe. The emission of electromagnetic radiation cause adverse health effect in mobile phone users. Some studies investigating the effect of MP on human health (on reproductive system, central nervous system, human auditory brainstem, cardiovascular system (CVS), cognitive functions and carcinogenesis etc.) have been published [1-3]. Radiofrequency (RF) electromagnetic fields (EMF) of mobile communication systems are widespread in the living environment. Exposition to high-power RF energy may have negative thermic effects on living organisms and cause cataracts, skin

burns, miscarriages or birth defects [4-5]. The influence of MP on heart rate and blood pressure is still problematic [6-8]. The effects of MP on heart rate (HR), blood pressure (BP), and heart rate variability (HRV) parameters were evaluated from a particular distance, at headset or handset position while MP was on or off position, and different results had been obtained [9-10]. Repeated exposure of mobile phone affects their normal regulation and cancer results [11]. Many authors suggest that electromagnetic fields emitted by cellular phones may interfere with work of cardiac pacemakers and other implantable medical devices [12-14]. The influence of mobile phones on different parameters of cardiovascular functioning was questionable in some of the cases [15-16]. It was shown that occupational exposition to EMF can cause fluctuations in heart rate and heart rate variability (HRV) [17-19]. It was observed that changes in heart rate and in arterial blood pressure were independent of the RF exposure with the use of 900 MHz mobile phones [16]. There are several reports which indicate that electromagnetic radiation (such as mobile phone) at non thermal levels may elicit a physiological effect on human body.

To date there is limited scientific of health issuer and no mechanism by which mobile phone radiation could influence cardiovascular system of human.

The present study was performed for determining the effects of radio frequency (RF) from mobile phones on heart rate, blood pressure and electrocardiographic potentials of human body.

METHODOLOGY

Subjects: The study was conducted on 10 young university male students having age range of 21-23 years. The subjects were apparently healthy. All subjects volunteered for the study.

Recording of Cardiovascular parameters: The heart rate, blood pressure and ECG potential of the human subjects were measured by a physiological recorder (BIOPAC Student Lab System). The BIOPAC system was connected with a computer by the help of AC power cord. Actually BIOPAC Student Lab Hardware or MP30 acquisition unit was connected with BIOPAC student Lab software. Three different channels of MP unit i.e. Ch1, Ch3 and Ch4 were selected for three different parameters like Blood pressure, heart rate and E.C.G respectively.

Heart rate is measured by the help of BIOPAC system using SS30L channel. Blood Pressure is measured by the help of BIOPAC system using SS19L channel. E.C.G wave characteristic is measured by the help of BIOPAC system using SS21 channel.

Experimental design: The experiments were performed under sitting posture to eliminate the effects of postural change on cardiovascular parameters. One cell phone was used by all the subjects during performing the experiment. With the help of BIOPAC system the heart

rate, blood pressure and E.C.G potential were recorded in control condition (without mobile) and during first ringing period of mobile phone (RF radiation- 900 MHz). Data were recorded by placing mobile phone at three different positions of the human body: (i) mobile phone in the pocket of shirt (above the chest), (ii) mobile phone in the pocket of trousers and (iii) mobile phone in the hand.

RESULTS

The mean values of heart rates of male subjects in control condition, that is, without using mobile phone and during ringing of mobile phone have been presented in Table 1.

Table 1: Mean \pm SD of heart rate with the change of mobile location in the body (n=10)

Placement of mobile phone	Heart Rate (beats / min)
	Mean \pm SD
Control (Without Mobile)	75.6 \pm 2.55
Mobile phone in the Pocket of Shirt	73.1 \pm 1.792*
Mobile phone in the Pocket of Trouser	74.6 \pm 2.503
Mobile phone in the Hand	73.3 \pm 2.132*

w.r.t Control *p<0.05

From the results it was revealed that the heart rate (HR) was significantly decreased (p<0.05) while using the mobile phone, that is, during ringing of an incoming call, from that of control condition (without mobile). Such significant changes were noted when the mobile phone was placed in the shirt-pocket as well as in the hand. No significant difference in heart rate was found between control condition and using the mobile in the hand.

The systolic and diastolic blood pressure of the male subjects was recorded in the experimental conditions stated in case of recording heart rates and the results were shown in Table2.

Table 2: Mean \pm SD of blood pressure in three different places of mobile (n=10)

Placement of mobile phone	Blood Pressure (mm-Hg)	
	Systolic Blood Pressure	Diastolic Blood Pressure
	Mean \pm SD	Mean \pm SD
Control (Without Mobile)	111.1 \pm 7.26	76.5 \pm 12.30
Mobile phone in the Pocket of Shirt	114.7 \pm 8.00	78.9 \pm 9.07
Mobile phone in the Pocket of Trouser	121.6 \pm 9.74*	78.1 \pm 9.44
Mobile phone in the Hand	119.5 \pm 10.20*	78 \pm 12.09

w. r. t control *p<0.05

The results (Table 2) showed that the systolic blood pressure of the male subjects was significantly ($p < 0.05$) increased while using mobile keeping it in trousers pocket from that of control condition (without mobile). The same results were obtained while using the cell phone keeping it on the hand. However, in case of diastolic pressure, no change was observed while using cell phone from that of control condition (without using mobile phone).

The ECG potential was recorded in different experimental conditions as stated in case of recording heart rate. The ECG was analyzed and different voltage parameters, viz., p-wave, QRS complex, T-wave as well as time parameters, viz., QRST interval, PP interval and RR intervals were computed. The voltage parameters have been presented in Table 3 and the time parameters were shown in Table 4.

Table 3 shows the ECG voltages of p wave, QRS complex, and T wave during using mobile phone keeping it in three different locations of the body. The QRS complex was computed as the relative value of the sum of Q, R, and S waves. It was noted that in all placements of mobile phone the amplitudes of P wave, T wave and QRS complex were found to increase during ringing of mobile phone from that of control condition (without using mobile phone), although the increments were statistically non-significant.

Table 3: Mean \pm SD of ECG voltages in three different placements of mobile phone n=10)

Placement of mobile phone	ECG Voltage (mV)		
	P	QRS complex	T
Control (Without Mobile)	0.045 \pm 0.019	0.908 \pm 0.223	0.288 \pm 0.104
Mobile phone in the Pocket of Shirt	0.043 \pm 0.021	0.941 \pm 0.249	0.312 \pm 0.118
Mobile phone in the Pocket of Trouser	0.057 \pm 0.014	0.962 \pm 0.206	0.308 \pm 0.116
Mobile phone in the Hand	0.061 \pm 0.046	1.045 \pm 0.291	0.317 \pm 0.131

In Table 4 the duration of three ECG intervals, viz., QRST, PR, and RR, have been shown during using mobile phone in three locations and control condition. The results revealed that there was no significant change in ECG intervals during using mobile phones from that of control condition. However, QRST interval showed a tendency to be increased during ringing of mobile phone in all the placements in the body from that of control condition (without using mobile phone).

Table 4: Mean \pm SD of ECG Intervals in three different placements of mobile phone

Placement of mobile phone	ECG Intervals (Sec.)		
	QRS T- interval	PR -Interval	RR -Interval
Control (Without Mobile)	0.905 \pm 0.488	0.278 \pm 0.210	1.296 \pm 0.467
Mobile phone in the Pocket of Shirt	0.940 \pm 0.458	0.221 \pm 0.139	1.221 \pm 0.343
Mobile phone in the Pocket of Trouser	0.956 \pm 0.459	0.172 \pm 0.151	1.349 \pm 0.423
Mobile phone in the Hand	1.037 \pm 0.516	0.209 \pm 0.110	1.243 \pm 0.357

DISCUSSION

Some studies carried out in the recent past have proved the effect of MP radiation on the heart rate. However, such kind of studies are actually lacking in this part of the country. So the present formal study was planned to evaluate the effect of MP radiation on cardiovascular system.

Some previous studies reported decrease in heart rate in MP radiation due to interference of electromagnetic radiation emitted by MP. Our study also showed significant decrease in heart rate while ringing of mobile placed in the pocket of the shirt and in the hand. Other studies also found a significant change in heart rate due to mobile phone ringing [20]. However, Colak et al expressed different views. They stated that the obtained results did not show significant differences in the BP, HR and ECG parameters [21].

Decrease in heart rate is indication of the increase in parasympathetic tone and decrease in sympathetic tone which may be major cause in decreasing heart rate in MP tone. These findings were also reported by some of the workers indicating the role of increased efferent vagal activity [20, 21].

The present study showed (Table 2) that blood pressure was increased due to MP tone. It was found that electromagnetic radiation exposure increased BP [19, 22].

In the present findings (Table 3 and Table 4) no significant difference was found in E.C.G waves and E.C.G intervals in subjects without MP and while the MP was ringing. However, Buczkowski et al showed that mobile phone ringing exerted influence on ECG recording while it was kept within 7.5 cm distance of recording system [23]. Karczmarewicz et al (2001) also noted the influence of radiofrequency on the accuracy of ECG recordings [24]. In our findings the amplitude of R wave (not shown in the table) and QRS complex was increased (non-significantly) during ringing of mobile phone in the chest pocket. Alhusseiny et al, also reported the increase of amplitude of R wave while mobile phone was used in the chest pocket [25]. Alhusseiny (2014) did not found any significant change ECG voltage parameters.

In the present study it was noted the QT interval was increased, although non-significantly, due to mobile phone ringing in adult male subjects. The results were inconformity with other study. Other investigators reported that the radiofrequency of cell phone prolonged the QT interval in human beings and it interfered with voltage criteria of ECG records in male patients with myocardial ischemia [25]. Mohamed et al showed similar effects on albino rats [26]. There was no significant difference in PR interval in our study. Similar results were also reported by Komeili and Sarabandi [20].

Our results showed no significant changes in PR interval during ringing of mobile phone. In contrary to that Alhusseiny (2014) noted significantly shortened P-R period as an effect of radiofrequency of mobile phone (turn ON mode) placed at belt level [27].

CONCLUSION

To conclude, our study demonstrated statistically significant difference in heart rate as well as in blood pressure resting (without mobile) and after the mobile phone ring, which reflected that mobile phone radiation has slight effect on heart rate and blood pressure. So, present study suggested that the radiation of the mobile phone have effect on cardiac electrical activity and therefore influence the variation in the heart rate, blood pressure and so change the autonomic balance.

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