EFFECTS OF ELECTROMAGNETIC RADIATION FROM 4G MOBILE PHONE ON HEART RATE AND BLOOD PRESSURE

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Abstract: For better communication, constant use of mobile phone is a common practice due to various low-priced free voice calling and internet facility given by telecommunication companies. Various studies indicated that the electromagnetic radiation from a mobile phone can be extremely detrimental, causing headache, dizziness, numbness in thigh, genetic damage, cancer, memory loss, increased blood pressure and weakening defense mechanism of body. The electromagnetic radiation emitted by mobile phone is invisible, vague, and enters and leaves our body. Present study deals with effect of radiation emitted by smart mobile phone on heart rate variability and changes in blood pressure on ten young volunteers. The experiment was conducted in a laboratory using ECG machine and BP monitor on young and healthy volunteers of age group 22-24 years. New Jio phones with head SAR 0.6 W/kg and body SAR 0.65 W/kg with 4G LTE connectivity were used as transmitter and receiver. Receiver and transmitter mobile phones were kept near mouth-head position. The period of communication was 15, 30 and 45 minutes continuously. Electrocardiograms were recorded by BPL machine having limb and chest electrodes. Electrodes were used to record the electrocardiogram (ECG) as per standard practice used in hospitals and guidelines supplied by BPL Company. Digital blood pressure monitor notices subject's blood movement through branchial artery which converts the movements of blood into a digital form. The model SEM-1 of Omron Company was used to record systolic and diastolic blood pressure for same intervals as mentioned above. The results indicated changes in both parameters when mobile phone was kept close to head, but the changes cannot be considered significant at p <.05 despite of noticeable changes in parameters. Furthermore, it is important to correlate such study with electrical activities of the brain recorded during use of mobile phone. The results obtained from such studies should be communicated to the user in a transparent and differentiated way.

Keywords: Smart phone, HR, BP, 4G, Electromagnetic radiation

Introduction

Use of mobile phone is a common practice all over the world and increasing continuously. As per Telephone Regulatory Authority of India data, there are 113.1 crores of mobile phone users in India. (about 86% of population). Out of them, India had 1.12 billions are active mobile connections with Airtel, Idea, Reliance Jio and Vodafone accounting for 91% of total active mobile connections. The number of mobile manufacturing companies with various attractive features is continuously increasing every year. With the invent of 3G and 4G connectivity, mobile phone provides wider multimedia applications in addition to its basic phone operations. To provide better coverage for mobile signals or connectivity more than 90 millions towers are erected in India. Mobile phone communicates through lower frequencies of electromagnetic radiation called non-ionizing radiation. People's concern regarding the biological effect of non-ionizing radiation has been a topic of debate from last decade. Non-ionizing radiation with frequency more than 100 KHz and higher produces thermal effects [1]. Companies' do not think about health hazards because of their business interest or the customers staying near tower zone also. The intensity of electromagnetic radiation from communication devices is increasing endlessly. It is known as an invisible and dangerous pollution that may affect life in numerous ways. Base transmission mobile towers give out electromagnetic radiation constantly which has adverse impacts on human, wild life and ecosystem [2, 3].

Cell phones emit low-levels radiofrequency (RF) radiations, some of which are absorbed into body. The amount of energy absorbed depends on many factors, such as how close you hold the cell phone to your body and the strength of the signals. Cell phones are designed to operate at the minimum power necessary to connect and maintain a quality of the call. The transmitting power of a cell phone varies, depending on the type of network and its distance from the cell phone tower. The Exposure of high power radiofrequency

energy may have adverse thermal effects on living organism. Majority of the users have reported that when they use cell phones for more than 20 minutes, their ear lobes get warmed. The problem begins with a pain in the ear that gradually develops into tinnitus or a ringing sensation which finally leads to hearing loss and ear tumor. Moreover overuse of cell phones leads to drying of the skin, drying of fluid in the eyes, sleep disorder, lack of concentration and memory loss [4].

Some investigators found that pulse rate does not change significantly when subjects were exposed to mobile phone radiation. However, the percentage decreases was recorded by people of age 40 years and above [5]. Many investigators have reported headaches, disturbed sleep, short term memory loss, hair loss, burning sensation and increase in cancer cases, cataracts formation in eye tissue, DNA damage, and neurological problems [6]. Studies have found that using a mobile phone for more than four hours a day is associated with reduction in sperm viability and mobility of around 25% [7]. A pregnant woman and the fetus both are susceptible because of the fact that these RF radiations continuously react with the developing embryo and increasing cells. Microwave radiation damages the placental barrier, implying that pregnant woman should not use cell phone [10]. Some investigators reported increase in heart rate variability when mobile phone was held close to head and impact of long term mobile phone usage on the heart rate variability [9, 10]. However some investigators have showed that the changes in cardiac parameter is small and does not show any a consistent trends while some reported that these changes are similar to daily activities as excitement and stand up stating their limitations of short term use of mobile phone [11-13].

Detailed evaluation of the study

Before the experiments, a survey based on questionnaire was carried out. The total numbers of respondents were 200 (100 Males and 100 Females). Out of them 23% students were using phone with two SIM cards simultaneously. 51% were getting more than ten calls per day and 45.5% students were calling others by dialing more than 10 calls every day. Almost 51% of the students reported about headache due to continuous use of mobile phones. Out of these, 90% felt that, base tower stations affect health, 83.5% felt possibility of induction of cancer due to this radiation. Also 70.5% students reported that due to radiation emitted by mobile base stations people were becoming hypersensitive to radiofrequency, 93% students knew that younger kids are more vulnerable for cell phone radiation and 50.5% admitted that they were irritated over issues informed them on mobile phone.

Nearly 32% students reacted absolutely at time of query on being short of attention. Further they admitted that they were more or less upset and disturbed by repeated calls/messages from callers. It was because callers did not allow them to continue with their scholastic activities. About 79.5% answered and agreed about some disturbances in sleep. They criticized for getting sleep much after they gave up work for the night, in spite of a 'exhausted' day and / or anxious sleep in which they woke up numerous times in-between.

Lack of educational progress was accredited to enrichment in cell phone practice, by 32%, whereas others did not believe that was the only real reason. Everyday disturbances during calling or receiving calls from friends or parents may affect attention and link in studies up to some extent only. About 26% respondent confessed that by continuous use of mobile phone, they have psychological problems. Nearly 23% said that they were further absentminded than they were earlier. They had common memory lapses due to dependence on cell phones which has ability to stores the information regarding mobile number, day to day work, calendar, events, and various days. They had feeling that that by using cell phone there is no need to learn by heart. In addition, 83% respondents told that excess uses of mobile phones affect study as they are addicted to mobile phones. They have lack of adequate knowledge about the detrimental effects due to cell phones. These could be the important causes that have added to the augmented occurrence of several health symptoms among the teenagers. It is believed that the side-effects due to cell phone use particularly on those who use mobile phone for longer times. Health hazards can be reduced by limited use of cell phone and not getting addicted to smart communication devices. The present work deals with measurements of blood pressure and heart rate using electrocardiogram (ECG) machine.

Methodology

Ten physically fit students of age 21.8 ($\pm$ 2.04) were selected for study. It is ensured that volunteers included in study were using cellular phone for more than 3 years earlier to the study. They were receiving 150 calls per month on an average. After informal discussion with volunteers included in the study, it has been observed that they were using the cellular phones for minimum 4 to 5 hours per day for communication and social media surfing. It has been also noticed that average time of mobile phone call was 8 to 10 minutes for each call due to free calling facility given by mobile phone network companies. The have averagely dialed

15 calls per day and maximum 500 calls per month. Mobiles phones were also used by them for sending SMS, using features like what's up, face book, camera and video facility for taking pictures, storing them and entertainments like hearing music, watching videos and playing games.

The criteria used for exclusion of students were:
1. Volunteers on medical treatment.
2. Occurrence of any rigorous cardiovascular syndrome together with arterial hypertension in the volunteers.
3. Volunteers having any pains of neurological system and metabolism of body that could affect heart rate and serious arrhythmias.
4. Volunteers addicted for smoking and habited for alcoholism.

All subjects were informed to avoid caffeinated drinks. They are also asked not to have unnecessary activities together with physical exercises and aerobatics within 6 hours prior the collecting data. They were also informed not to have food or tea prior to experiments. Volunteers were given information regarding the equipments being used for examining the procedure of study and experimentation. The study was completed in a silent, airy and spacious room in seating position. Necessary oral consents for the study were taken from all students included in the study.

Recordings of parameters were carried out for about 45 minute during 10 am – 11 am every day under same circumstances, at the same position of the study and in sitting situation. Pilot study was carried out for continuous one hour communication. The time of maximum exposure was determined by observing effect of one hour of exposure of radiation. Readings were taken prior to the mobile call (control), after interval of 15 minutes. The mobile hand set used for the experiment was Jio phone. Jio phones with head (Specific absorption rate) SAR 0.6 W/kg and body SAR 0.65 W/kg with 4G LTE connectivity were used as transmitter and receiver. Receiver and transmitter mobile phones were kept near to mouth-head position. The period of communication was 15, 30 and 45 minutes continuously. Systolic and diastolic blood pressure was noted for all selected volunteers using BP monitor SEM-1 of OMRON Company as shown in fig.1

Fig 1: BP monitor SEM-1 of OMRON

Electrocardiograms were recorded by BPL machine Cardiart 108 T-DIGI as shown in Fig.2. It is having four limb and one chest electrodes (Fig.3). Electrodes were used to record the electrocardiogram (ECG) as per standard practice in hospital. Out of five electrodes, two limb electrodes on legs(LL,RL), two limb electrodes on hand(LA, RA) were placed, one suction cup electrode is placed on chest near the SA node of heart as per standard used in hospitals by cardiologist with proper application of jelly. Electrode jelly is used for good contact between skin and electrodes also to reduce the surface skin resistance. For pasting electrodes Ag-AgCl jelly was used as shown in Fig.3. The mobile phone was kept in 'on position' during period of conducting experiments so that the consequence of logging into the mobile networking at the maximal release of radiation could be avoided. Electrocardiograms are almost invariably recorded on graph paper with horizontal and vertical lines at 1 mm intervals with a thicker line at 5 mm intervals. Time measurements and heart rate measurements are made horizontally on the electrocardiographs. For routine work, the paper recording speed is 25 mm/sec. The sensitivity of an electrocardiograph is typically set at 20 mm/mV.

By knowing the distance between RR peaks heart rate can be calculated by formula:

$$Heart\ Rate\ (BPM) = \frac{Chart\ speed\ (mm/sec)}{R - R\ interval\ (mm)} x\ 60$$

. The results obtained are compared with normal ECG of every subject which was taken before study. Mean value and standard deviation in heart rate is calculated for comparative study. Students 't' test was used to observe the significance of the study. Generally, non debatable, non-exciting or non-irritating and unbiased issues were discussed during the cell phone communication to reduce the stress linked with talking and successive excess activity of autonomic nervous system. The volunteers were in trouble-free sitting position. They were not allowed to make any bodily movement. Various parameters were recorded for 45 minutes when volunteer was continuously communicating with other person on normal issues.
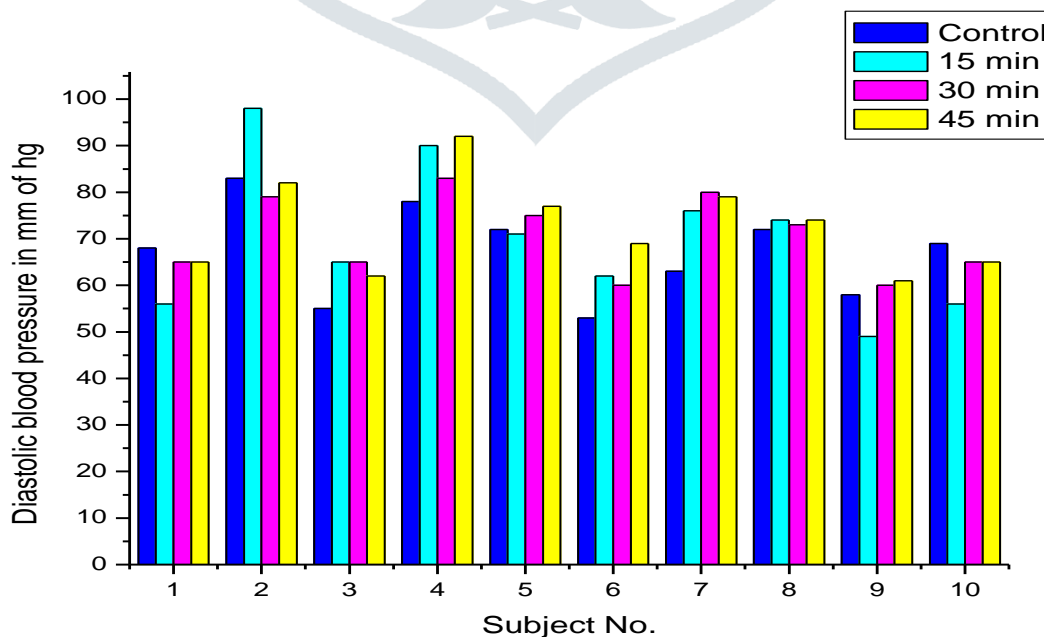

Fig 2. ECG machine and typical ECG recording



Fig.3 Limb, chest electrodes and electrode jelly

Results and discussion

Results obtained from changes in diastolic blood pressure in mm of Hg are shown in Fig. 4.

Fig.4: Changes in diastolic blood pressure in mm of Hg recorded by OMRON SEM1 BP monitor

Control reading represents values at normal condition and other values are for 15 min, 30 min and 45 min of exposure from mobile phone radiation. Fig. 5 represents systolic blood pressure in mm of Hg for same interval.
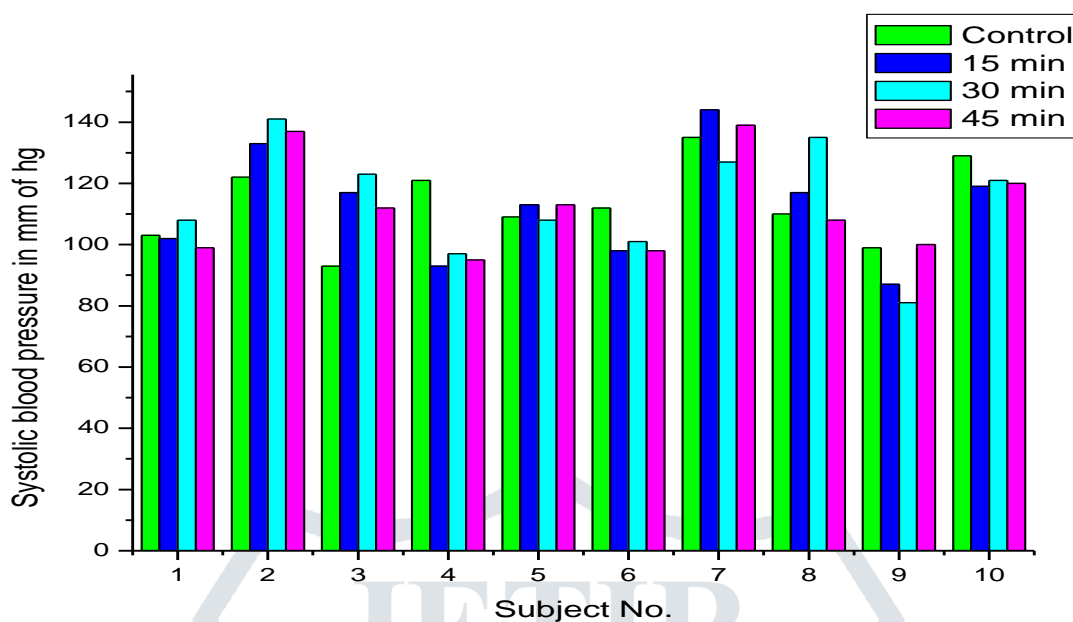
Fig.5: Changes in systolic blood pressure in mm of Hg recorded by OMRON SEM1 BP monitor

Similarly Fig. 6 represents changes in heart rate in bpm for above mentioned periods.
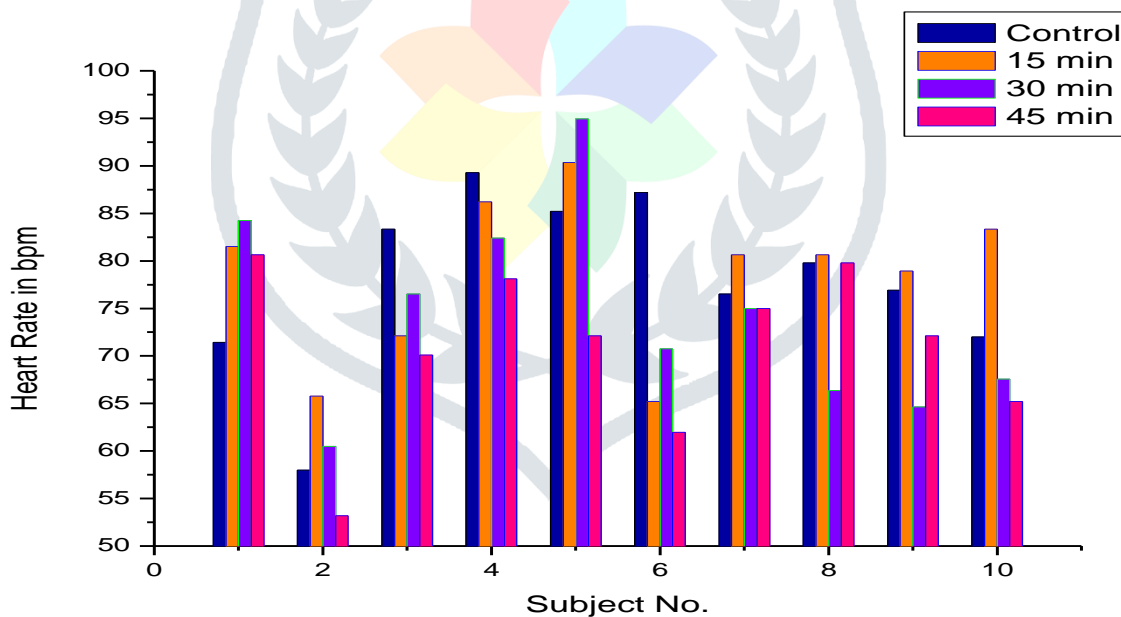
Fig.6: Changes in Heart rate in bpm recorded by BPL Machine

In the present study, all the ECG traces parameters lie in normal range before and after an acute exposure to mobile phone radiations. According to American Heart Association, the normal human heart rate should be lie in between 60 and 100 bpm and in this study average heart rate decreases from 78 to 70 after 45 min exposure. These results of the present ECG study are in close agreement with other investigators [14].
In addition to heart rate, no change has been also observed.. The normal range for systolic and diastolic BP lies in between 120 and 80 mm of Hg respectively. In this study, average range is shown in table..

Conclusion:

Using student t test software, the t and p values for above set of observations were calculated and represented in Table 1 and Table 2.

Table 1: Statistical analysis of Blood Pressure

Parameters ⟶	Diastolic blood pressure in mm of Hg				Systolic blood pressure in mm of Hg			
Time of exposure ⟶	O min	15 min	30 min	45 min	O min	15 min	30 min	45 min
Mean	67.1	69.7	70.7	72.6	113.3	112.3	114.2	112.1
Standard deviation	9.82	15.48	8.88	10.01	13.35	17.78	18.52	15.75
t value	-	-0.44	-0.85	-1.23	-	0.14	-0.12	0.18
p value	-	0.65	0.40	0.23	-	0.88	0.90	0.85

Table 2: Statistical analysis of Heart rate

Parameters ⟶	Heart rate in bpm(beats per minute)			
Time of exposure ⟶	O min	15 min	30 min	45 min
Mean	77.97	78.46	74.29	70.82
Standard deviation	9.29	8.30	10.54	8.63
t value	-	-0.13	0.83	1.78
p value	-	-0.90	0.42	0.09

In the present study, it has been observed that, mobile call changes heart rate of healthy volunteer. Mobile phone radiation affects heart rate variability but the effect of speaking on mobile phone cannot be ignored. The result indicated increase in HRV parameters even near to head while talking for 45 minutes.

Present study is a single-blinded study for the analysis of cell phone radiation effect on human heart and blood pressure in which no statistical significant variation has been reported. But in future, more research work can be carried out with a people of different age groups using different methodology. So for future, studies can be carried out for long exposure duration. Parameters studied shows statistical non significance due to large standard deviation but the values are significant at the individual level. The heart rate changes by 8 to 10 value is physically considerable. Study is limited for 10 volunteers only; we feel that for statistical significance, more subjects should be considered with male and female separately.

Mobile phone production industry is like a cigarette production industry. Cigarette companies publically agreed that smoking is injurious to health and same warning is printed on cigarette packets. Still millions of people are becoming victims of smoking inviting pulmonary and respiratory disease like tuberculosis, asthma etc. We can't view radiation emanated from mobile phone or smell it, but its effects are observed after long term exposure during its use.

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