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Influence of Mobile Phone Electromagnetic Radiation Wave on ECG parameters in Chest Pocket Level during Silent Mode among Healthy Adult Volunteers

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Original Research Article

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Abstract: Background: It was an experimental comparative study conducted in Sudan, faculty of healthy sciences at Alsheikh Abdallah Elbadri University, among 144 Sudanese and non-Sudanese volunteers, age between 16 to 49 years old. ECG was done before and after exposure to mobile cell phone and both results was compared. The mobile cell phone was placed on chest pocket level during silent modes. Objectives: The study was aimed to detect the effect of silent mobile phone electromagnetic radiation on ECG parameters in both genders. Results: ECG parameters mean +STD of P, PR, ST and QT have significant change within normal range correlated with heart rate and rhythm, while the mean +STD of QRS duration and T wave has no significant changes. Conclusion: The mobile phone wave during silent mode has direct effect on ECG parameters which leads to sinus arrhythmia.

Keywords: ECG, Electromagnetic phone radiation, silent, chest pocket level, healthy volunteers

INTRODUCTION

Spectrum of electromagnetic waves has an extensive frequency range from 300 Megahertz to 300 Gigahertz and their wave lengths vary from 1 mm to 1 m. Waves emitted by mobile phones with an average frequency of 900 MHz to 1 Gigahertz [1].The short- or long term variation of heart rate was measured by beat-to-beat analysis. Heart rate variability represents a variable marker of autonomic activity and provides useful information on autonomic failure. Heart rate variability is influenced by factors such as age, gender, respiration and fitness. The variability of heart rate is divided into high frequency (0.15-0.40 Hertz), low frequency (0.04-0.15 Herz), and very low frequency (0.0-0.04 Herz) [2].

The use of mobile phone has been increasing dramatically in the past decade. World Health Organization has estimated that currently there are 4.6 billion subscriptions globally [2]. The current digital global system for mobile communication operates through radiofrequencies ranges from 900 Megahertz to 1800 Megahertz [3]. Medical equipment is expected to make correct recordings related to patients' problems. It has been reported that mobile phones are interfering with the recordings and results in incorrect data collection [4, 5]. It is well known that any electromagnetic source can harm electronic equipments as well as the living [6, 7] Therefore mobile phones are very serious interfering sources.

Electromagnetic interference related errors of ECG processing algorithms implemented in stand-alone ECG devices can influence doctor's diagnosis. Furthermore, such errors may influence algorithms implemented in medical devices, e.g., leading to errors in differentiation between shockable and non-shockable arrhythmia by Automated External Defibrillator. Studies of interactions of Global System mobile phones with pacemakers confirmed that in order to cause interference the mobile phone had to be closer than 10 cm to the pacemaker pocket [8, 9].

Similar results were obtained for both unipolar and bipolar ECG sensing configurations. Various studies revealed that the exposure to RF leads to adverse effects on reproductive system, cardiovascular system, autonomic nervous system as well as immune system [10, 11]. Both human epidemiological studies and animal based (experimental) studies are demonstrating the carcinogenic potential of Radiation frequency of generated electromagnetic field [12, 13].

A cardiac electrophysiology study is a minimally invasive procedure that tests the electrical conduction system of the heart to assess the electrical activity and conduction pathways of the heart. During EPS, sinus rhythm as well as supra ventricular and ventricular arrhythmias of baseline cardiac intervals is recorded [14].

SUBJECT AND METHODS

Study area

This study was carried out from March 2014 to August 2016 in skills laboratory of the faculty of health sciences at Faculty of Health Sciences at Elsheikh Abd Allah Elbadri University in North of Sudan.

Study population

Healthy adult volunteers from both gender more than 16 to less than 50years old who study or work in the faculty of health sciences at Elsheikh Abd Allah Elbadri University. The samples were selected by cluster Simple random technique.

Study design

Experimental analytic comparative study about the effect of mobile phone cell wave on ECG parameters of healthy adult male and female with different ages, during mobile phone positioned on the chest pocket level and during mobile phone on ringing modes. This study was conducted by 2 phases:

1. ECG procedure performed in the absence of mobile phone.
2. ECG Performed on the presence of mobile phone during silent mode, at the chest pocket level.
3. Comparison between the results in first 10 second, 20 seconds and 30 seconds post exposure.

Ethical approval

Permission to carry out the study from the responsible authorities was taken. The procedure was explained to volunteers to provide privacy for female. The objectives of the study were known by volunteers& their verbal acceptance was considered. The study protocol was approved by the institutional ethics committee of the university prior to the commencement of the study. The clinical study was performed after informed verbal consent was obtained from all the volunteers.

Description of Study Procedure

The volunteers were asked not to drink tea, coffee or cola containing beverages or alcohol before 30mintues of ECG recording to minimize the effect of these factors on ECG parameters or heart rate. The participants were requested not to use mobile phone before 30mintues of the recording of the ECG. We used volunteers' mobiles cell (2G, 3G, and Nokia during study time). The phone was on silent mode placed in the left chest pocket level (anterior wall of the chest) for male and female and 12-leads ECG was recorded to the participants (supine position). The 12-lead ECG (baseline) was recorded using ECG machine (6 canals) when mobile was absent and performed 12leads ECG during post mobile phone cells exposure. ECG was performed for 144 volunteers in the absence of mobile phone as baseline data and the pulse rate was calculated manually before exposure to mobile phone wave.

Data analysis

After the data collection, it was coded and transferred into especially designed formats so as to be suitable for computer feeding, following data entry, checking and verification process were carried out to avoid any errors during data entry. Frequency analysis and manual revision was used to detect any errors.

Data analysis method

The data was analyzed by using statistical package of social science (SPSS), Frequency presented mean and stander deviation, paired T test and cross tabulation were used for data analysis as statistical tests and excel program was used for figures and was presented in tables, figures presentation include: Bar graph, pie graph.

RESULTS

In table 1: results appear as the following:

Table-1: The effect mobile in silent mode at chest pocket level On ECG parameters on silent mode at chest pocket level

	B	A1	A2	A3
	Mean ± Std.	**Mean ± Std.**	**Mean ± Std.**	**Mean ± Std.**
P	0.112± 0.016	0.088±0.018	0.114±0.014	0.102±0.024
P value		**0.000**	**0.045**	**0.000**
PR	0.160± 0.019	0.134±0.020	0.167±0.022	0.152±0.026
P value		**0.000**	**0.000**	**0.001**
QRS	0.047±0.010	0.047±0.010	0.047±0.010	0.047±0.010
P value		-	-	-
ST	0.281± 0.017	0.252±0.023	0.286±0.022	0.269±0.026
P value		**0.000**	**0.003**	**0.000**
T	0.092±0 .034	0.092±0.034	0.093±0.034	0.094±0.036
P value		**0.529**	**0.158**	**0.015**
QT	0.321± 0.018	0.292±0.023	0.325±0.021	0.308±0.026
P value		**0.000**	**0.030**	**0.000**
Voltage	1.343± 0.437	1.256±0.474	1.314±0.430	1.319±.423
P value		**0.000**	**0.000**	**0.001**

P wave duration result :The Mean ± Std of P wave was significantly decrease before and after phone exposure in first 10 second post exposure, p value(0.000) , while the p value of p wave in 2ed 20 second is (0.045) not significantly decrease. The 3ed 30 second the p wave p value is(0.000) there was significantly decrease. This results appear in figure No 1.

Fig-1: The effect of mobile phone on ECG parameters (P wave)

PR interval result :The Mean ± Std of PR duration was significantly decrease in first 10 second p value(0.000) and 3ed 30 second p value(0.001) ,while it was significantly increase in the 2ed 20 second post exposure p value (0.000) . This results appear in figure No 2. The changes in duration of PR was within normal range no signs of heart block was appeared.

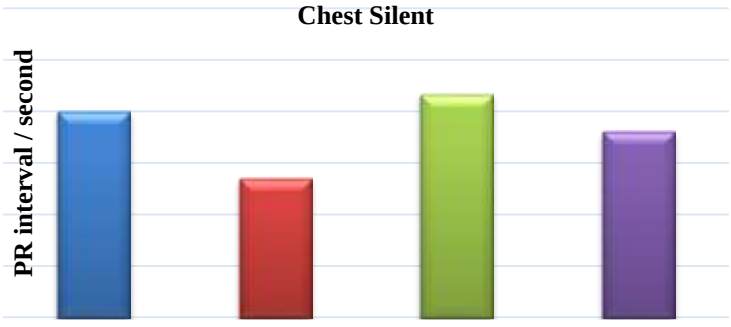

Fig-2: The effect of mobile phone on ECG parameters (PR interval)

QRS wave duration result :There was no any change in the Mean ± Std of QRS duration before and after phone exposure in first 10 second and 2ed 20 second and 3ed 30 second, according to equality of all Mean ± Std in all duration there is no p value appearance in all duration , as revealed in table (1). This results appear in figure No 3.

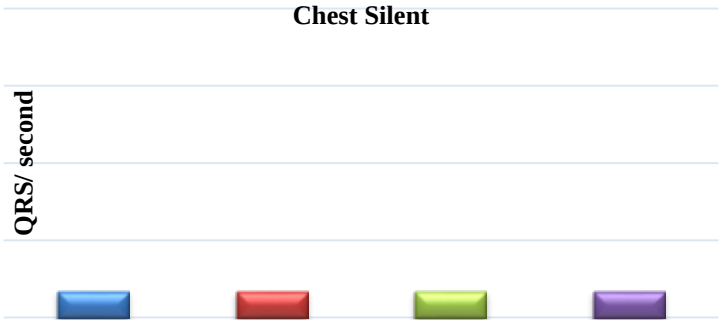

Fig-3: The effect of mobile phone on ECG parameters (QRS wave)
Source: prepared by the researcher Questionnaire data, 2017used *SPSS* program https://www-01.ibm.com/support/docview.wss?uid=swg27038407

ST segment duration result :The Mean ± Std of ST duration is significantly changes in ST segment was significantly decrease in first 10 second p value(0.000) and 3ed 30 second p value(0.000), while it was significantly increase in the 2ed 20 second post exposure p value (0.003) before and after phone exposure. This results appear in figure No 4. No ST elevation or depression appears during test.

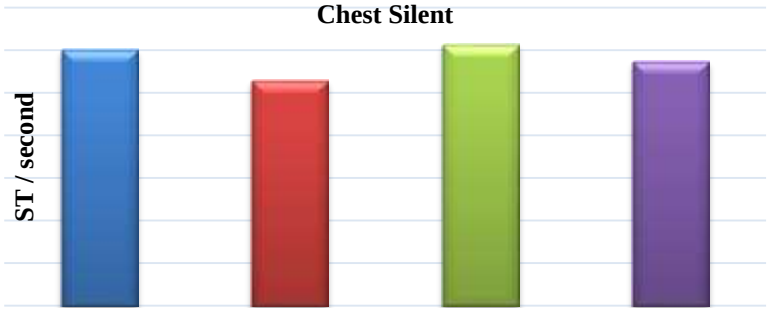

Fig-4: The effect of mobile phone on ECG parameters (ST segment)

T wave result :The Mean ± Std of T duration was not significantly increase before and after phone exposure in all duration , in the first 10 second the p value(0.529) , in the 2ed 20 second p value(0.158) and in 3ed 30 second p value(0.015) as revealed in table (1). This results appear in figure No 5. There was no change in T wave amplitudes.

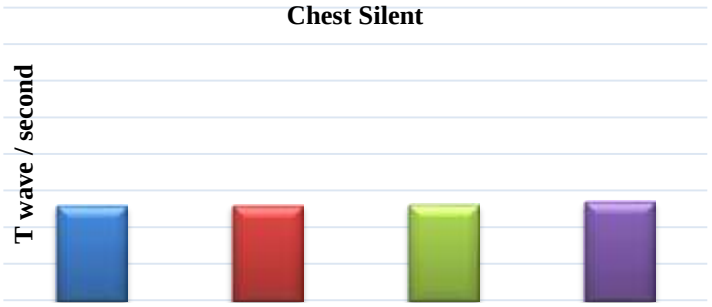

Fig-5: The effect of mobile phone on ECG parameters (T wave)

QT duration result :The Mean ± Std of QT duration was significantly decrease in the first 10 second p value(0.000) and 3ed 30 second p value(0.000) ,while it was not significantly increase in the 2ed 20 second post exposure p value (0.030) before and after phone exposure .This results appear in figure No 6.

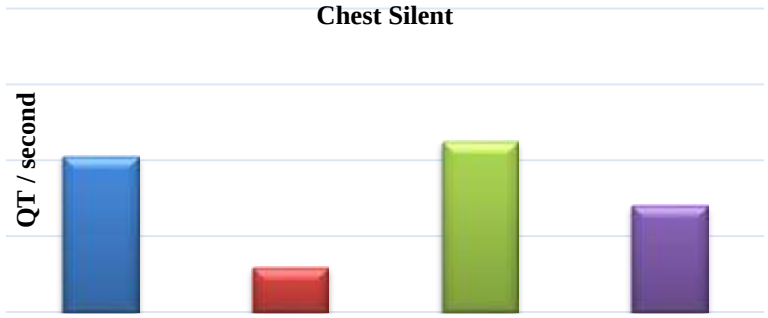

Fig-6: The effect of mobile phone on ECG parameters (Q T duration)

QRS Voltage result :The Mean ± Std of QRS voltage was significantly decrease before and after phone exposure in all duration, in the first 10 second p value (0.000), in the 2ed 20 second p value(0.000) , while the p value is (0.001) in 3ed 30.As explained in table (1). This results appear in figure No(1.7). The change in voltage was about- 0.1mv.

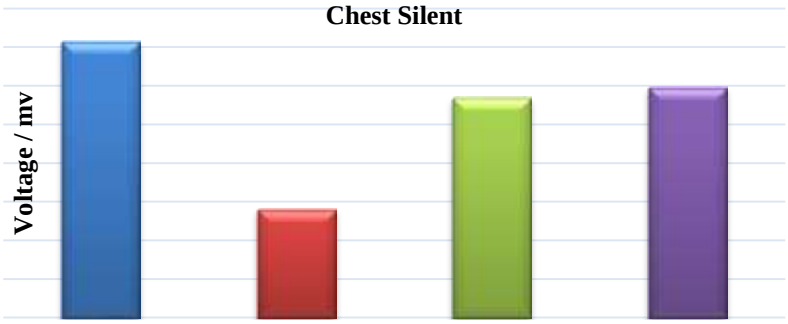

Fig-7: The effect of mobile phone on ECG parameters (voltage)

DISCUSSION

This study conducted to detect the effect of silent mobile phone electromagnetic waves on ECG parameters. The result revealed that there is clear influence of acute exposure to mobile phone wave on ECG parameters. Our study calculate p values for all ECG parameters (P wave, PR interval, QRS, ST segment, T wave, QT interval and QRS voltage) by using SSPS and T –paired test to compare between Mean ± Std for all above ECG parameters before and after mobile phone exposure. The Mean ± Std of P wave duration significantly changed over first 10 seconds post phone exposure, while it was not significantly changed over the next 20 seconds post exposure and it significantly changed over 30 seconds post exposure. The Mean ± Std of PR interval significantly changed over the first 10 seconds and over 2 ^{ed} 20 second post phone exposure and it was not significantly changed during the 30 second post Our study results was similar to that Alhusseiny who noted significantly shortened P-R period as an effect of radiofrequency of mobile phone (turn ON mode) placed at belt level [16]. The Mean ± Std of QRS wave during exposure to mobile phone has no significant changes in all durations. This result is similar to the result of another study conducted 2012 which noted that there wasn't any significant difference in time of QRS wave in any of the groups under study [17].

The Mean ± Std of ST segment duration showed that there was significant changed over 1 st 10 seconds post mobile exposure , while the Mean ± Std ST segment did not significantly changed over the next 20 second and in 30 seconds post exposure it is significantly decreased in ringing mode . The presented study showed that the Mean ± Std of T wave while mobile phone on the chest pocket level was not changed. No ST elevation or depression was noted.

The study also investigated the mobile phone effect on QT interval duration ,the result of Mean ± Std of QT revealed that it was significantly changed over 10 seconds post exposure ,while it was not changed significantly over 20 second and it was significantly changed over 30 seconds post exposure**.** On other hand the study investigated the voltage of QRS while mobile phone on the chest pocket level, the result showed the Mean ± STD of the ECG voltage did not significantly change during ringing mode

Also our study result is similar to study result conducted by 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 [18]. And similar to study result conducted by Kaviannezadet reported the onset of sinus arrhythmia as the result of mobile phone wave [19].

Our general results about the effect of mobile phone on ECG parameters was near to result of another study done by Komeili G, Nabizadeh *et al*, Studying the Effects of Mobile Phone Waves on Electro Cardiogram Parameters of Students in Zahedan University of Medical Sciences. This study was conducted in order to survey the effects of mobile electromagnetic waves on electro cardiogram parameters as heart rate, TP segment, PR interval, Time of QRS and T waves, and voltage of R wave. Results**:** There was significant difference between heart rate during talking in comparison with heart rate during ringing and resting in both genders. There was a significant decrease of resting TP segment in comparison with TP segment during ringing and talking in males whereas in females TP segment indicated significant difference in all three conditions. There was a significant increase in T wave time in males during talking in comparison with resting and ringing; however there was no significant difference in that of females in any of the three stated conditions. This study revealed that there was no any significant difference in PR interval, Time of QRS wave and R wave voltage. According to the results of this study, mobile phones can affect the heart rate, TP segment and time of T wave [17].

Our finding not was not similar to another study conducted in Niger 2014, the study aimed to assess Effect of Mobile Phone Radiofrequency Electromagnetic Fields on, showed no significant difference. The ECG parameters (HR: beats/min, QRS: ms, PR: ms and QTc respectively) did not differ before and after calls [20]. The result is different from our result because they investigated small numbers only 18 volunteers and we investigated 144 volunteers.

CONCLUSION

According to the results of this study, silent mobile phones can affect the ECG parameters, it seems that long term use can affect heart. There for further studies are needed to detect the effect of mobile phone on ECG parameters.

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