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Original Article

The Effect of Electromagnetic Fields Emitted from Mobile Phone on QT Intervals and Dispersion among Hypertensive Subjects

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ABSTRACT

Background: There is increasing public concern about the possible health risks associated with the electromagnetic field emitted by mobile phones with conflicting data about these risks. Prolonged QT interval and or increased dispersion have been associated with increased cardiovascular risk and mortality in health and diseased states even among hypertensives. **Aim:** To study the effects of electromagnetic field emitted from mobile phone on QT intervals and dispersions among hypertensives. **Subjects and Methods:** 100 hypertensive patients were compared with age and sex matched controls. Five sets of 12 lead resting ECGs were obtained from each participant, baseline ECG obtained without mobile phone. ECGs were obtained during 4 experimental settings: Mobile phone over the precordium turned ON not ringing, then in RINGING mode; then at the hip level turned ON and lastly on hip RINGING.QT interval and dispersion were manually measured from each of the ECGs. **Results:** Overall, there tended to be the longest QT intervals with the phone ringing on the precordium of hypertensive patients, though this was not statistically significant with ANOVA. However there was significant prolongation of the QTc intervals in hypertensives with the phone ringing on precordium compared to hip QTc (432.84+24.38 vs 430.72 +26.40 ms, p= 0.038); QTc_{max} (455.04+27.78 vs 450.28+27.77msecs p=0.002). This trend was absent however with QT dispersions. All the baseline QT intervals were longer in hypertensives compared with controls**. Conclusion:** Short-term exposure to electromagnetic field emitted by mobile phone interferes with QT intervals in hypertensive patients particularly when ringing on the precordium.

Key words: Electromagnetic field, Hypertensives, Mobile phone, QT intervals.

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INTRODUCTION

Electromagnetic (EM) field is composed of waves of electric and magnetic energy moving through space and produced by electrically charged objects. Mobile phones (MP) transmit at the radiofrequency (RF) range and these are ordinarily Non ionizing radiation.[1] Concerns however continue to be raised about the potential adverse health impacts associated with mobile phone use.[2] Whereas World Health Organization has acknowledged that EM fields could influence human environment,[3] there is no consensus that EM field emitted from MP poses a definite threat to human beings.[4]

According to the World bank, about 3/4 of the world population now have access to mobile phones[5] and Nigeria ranks 11th in the world in area of MP use.[6]

There has been suggestions that the EM field may affect the autonomic nervous system[7,8] and indirectly the QT intervals since these are modulated by the sympatho-vagal system.[9,10] Al Hussein *et al.*[11] reported that EM energy radiated from MP prolonged the QT intervals and affect the voltage criteria of patients with ischemic heart disease.

The QT interval is the electrocardiographic manifestation of total ventricular depolarization and repolarization and when corrected for heart rate it is QTc. The QT dispersion, on the other hand, is the difference between the longest and shortest QT interval on a 12 lead ECG and it is a measure of the heterogeneity of myocardial repolarization.[12] Whereas prolonged QT intervals have long been associated with dangerous arrhythmias and increased mortality in conditions like hypertension, ischemic heart disease and diabetes,[13] the Rotterdam study has shown that elongated QT dispersion, on its own, is a strong and independent risk factor for cardiac mortality in older patients.[14]

The prevalence of hypertension in our adult population has been put at about 20%,[15] with prevalence of prolonged QTc in our hypertensive population averaging about 50%.[16,17] With this our large population of hypertensive patients, many using the MP, it is imperative to investigate the effects of EM field emitted from the MP on QT intervals in them and also to find out whether the changes are associated with dangerous arrhythmias. We also sought to find out whether the position of the MP and whether ringing or not affected the QT intervals.

MATERIALS AND METHODS

100 hypertensive patients with repeated blood pressure measurement > 140/90 mm Hg or on antihypertensive therapy who gave informed consent were recruited into the study. They had full history and clinical examination done and were certified not to be taking drugs likely to prolong the QT intervals at the time of the study. Both the patients and controls had biochemical parameters checked.

All patients had a baseline 12 lead ECG done. A Nokia 202 mobile phone with IMEI –35471059471542 with specific absorption rate (SAR) < 2.0 watts/kg was then placed on the left side of the chest without contact with the electrodes. An ECG was recorded in the ON position without ringing. The ECG was repeated in this position when the phone was RINGING for 40 secs having been dialed by a research assistant a few meters away. The whole process of ON/RINGING was repeated with the MP placed on the hip.

Sixty eight (68) normal controls were taken through the same process.

The QT intervals were manually measured on the ECG as previously described by us[18] and corrected for heart rate by using the Bazett formula. Prolonged QTc was taken as QTc> 440 msecs and prolonged dispersion taken as QTcd >80 msecs. Only subjects who were in sinus rhythm and had a minimum of 8 measurable leads were analyzed.

Ethical approval was obtained from our Institutional Board

StatisticalAnalyses

Data were entered into computer and analyzed with SPSS version 20.0. Qualitative variables were presented as frequency while discrete variables were presented as Means and Standard Deviation (SD). The chi-square test was used to test for differences between means and proportion while the paired *t* test was use to assess the difference in means of QT parameters between precordium and hip.

ANOVA was used to compare the effects of the MP on the QT interval across board from baseline through the 4 experimental positions.

p value less than 0.05 was taken as significant

RESULTS

There were 100 hypertensives and 68 normotensive control subjects with analyzable ECGs. The participants were well matched.

The mean duration of MP use in the hypertensives was 8.72±3.17 years compared with 8.86 +2.62 years in the controls. The mean duration of hypertensive diagnosis was 7.90 ± 4.78 years. The baseline QTc and QTc_{max} was significantly longer in patients than controls. There were more patients with elongated QTc, QTc_{max} and QTd than controls (Table 1).

Table 2 shows the overall comparison of the hypertensives and the state of MP analyzed by ANOVA. Though there was no significant prolongation across board, the longest QTc, QTc_{max} and QTc_{min} were observed when the phone was ringing on the precordium. The dispersion variables were however longest on the hip. Similar observation was made also in the control group.

In Table 3, there was significant prolongation of QTc and QTc_{max} in the hypertensives compared with the controls. These prolongation persisted at baseline and through all the positions of the mobile phone ON/RINGING. These prolongations though slightly exceeded the critical value of 440ms were not associated with dangerous arrhythmias. The QT dispersion variables did not however differ between hypertensives and controls irrespective of phone position or mode.

Table 4 shows the comparison of the QT parameters between precordium and hip placement of the phone. All the QT intervals were significantly longer with the phone ringing on the precordium compared with the hip. These prolongations were again not observed in the dispersion variables.

DISCUSSION

This is an experimental study that investigated the effect of the EM emitted by mobile phone on the heart at different positions and modes. In this study in which the hemodynamic and biochemical characteristics of the hypertensives and controls were similar, the baseline QT parameters were longer, a trend that has been previously noted in our setting.[16,17] One of the reasons why this may be so is presence of left ventricular hypertrophy which is known to elongate QT and present in 64% in this study.The prevalence of prolonged QTc_{max} in this study at 68% is more than 48.5% noted in a previous study in our center[16] 'but comparable to' an important finding of this study was that the QTc intervals were generally longer with the phone on the precordium compared to the hip in hypertensive patients. These prolongations became even more with

Table 1: Clinical and Demographic Characteristics of all Subjects.

VARIABLE	Hypertensives (n=100) Mean (SD)	Normotensives (n=68) mean (SD)	*p* value
Age (years)	54.11 (11.50)	53.12 (11.76)	0.120
Males (%)	47(47.0)	28 (41.2)	0.830
Duration of HT (years)	7.90 (4.78)	-	-
Duration of mobile phone(years)	8.72 (3.17)	8.66 (2.62)	0.765
BMI (Kg/m2)	28.49 (5.29)	25.16(4.67)	0.002
SBP (mm Hg)	154.23(20.35)	123.11(14.24)	0.000
DBP (mm Hg)	95.23(16.64)	78.95(15.84)	0.000
PCV (%)	38.39(4.02)	35.53(3.84)	0.254
Serum sodium (mmol/L)	136.92(5.04)	133.7794.71)	0.080
Serum calcium (mmol/L)	2.42(0.06)	2.42(0.09)	0.974
Urea (mg/dl)	22.8(7.2)	17.5(2.2)	0.053
Creatinine(mg/dl)	0.76(0.19)	0.78(0.09)	0.777
Baseline QTc(msec)	432.69(25.32)	421.46(20.15)	0.005
Baseline QTc_{max}(msec)	451.98(30.26)	441.81(25.58)	0.024
Baseline QTc_{min}(msec)	410.40(28.17)	402.88(19.77)	0.058
Baseline QTd(msec)	37.14(18.60)	33.91(15.55)	0.327
Baseline QTcd(msec)	41.15(20.42)	38.32(17.70)	0.354
Baseline normal ECG (n%)	41(41.0)	48(70.6)	0.001
QTc >440 msec (n%)	37(37.0)	10 (14.7)	0.001
QTc_{max} >440 msec (n%)	68(68.0)	35(50.7)	0.010
QTd >40 msec (n%)	22(22.0)	8(11,6)	0.109
QTcd >80 msec (n%)	5(5.0)	2(2.9)	0.394

Table 2: QT Parameters in relation to mobile phone position/mode in hypertensives.

Parameters	Baseline	Praecordium (ON)	Praecordium (RING)	Hip (ON)	Hip (RING)
		[Mean msec (SD)]			
QTc	432.69(25.32)	431.88(25.40)	432.84(24.38)	431.62(25.34)	430.72(24.60)
QTc_{max}	451.98(30.26)	453.55(29.77)	455.04(27.78)	452.46(28.26)	450.28(27.77)
QTc_{min}	410.40(28.17)	409.47(28.23)	410.59(28.97)	407.07(27.25)	406.94(28.33)
QTd	37.14(18.60)	38.50(20.91)	38.69(18.93)	39.07(17.56)	38.89(18.89)
QTcd	41.15(20.42)	44.33(23.70)	44.42(21.63)	45.40(19.22)	43.31(21.72)
		ANOVA $P>0.05$			

Table 3: Comparison of QT intervals in hypertensives and control subjects.

	QTc mean (SD)			QTcmax mean(SD)		
Variable	Subject	Control	P value	Subject	Control	P value
Baseline	432.69(25.32)	421.46(20.15)	0.005	451.98(30.26)	441.81(25.58)	0.024
P/ON	431.88(25.40)	419.33(18.22)	0.001	453.55(29.77)	441.78(24.08)	0.010
P/RING	432.84(24.38)	419.98(19.54)	0.001	455.04(27.78)	441.48(26.42)	0.003
H/ON	431.62(25.34)	420.50(20.10)	0.004	452.46(28.26)	441.29(24.42)	0.015
H/RING	430.72(24.60)	421.24(21.09)	0.013	450.28(27.77)	439.15(24.50)	0.013

P/ON – Phone ON in precordium

P/RING – Phone RINGING on the precordium

H/ON – Phone ON at hip

H/RING – Phone RINGING at hip

Table 4: Comparison of QT intervals in praecordium and hip in all hypertensive patients.

Parameters (msec (SD))	Praecordium (RINGING)	Hip(RINGING)	P value
QTc	432.84(24.38)	430.72(24.60)	0.038
QTc_{max}	455.05(27.78)	450.28(27.77)	0.002
QTc_{min}	410.59(28.97)	406.97(28.33)	0.016
QTd	38.69(18.93)	38.89(18.89)	0.091
QTcd	44.42(21.63)	43.31(21.72)	0.556

the phone ringing. However these observations were absent in the control subjects. It is not clear why there were elongations in hypertensives and not in normotensives. It has been shown that acute exposure to EM field emitted by mobile have no significant effects on the normal heart and may not interfere with the electrical activity of the heart including QTc in healthy normal adults.[19,20] Left ventricular hypertrophy common in hypertension may be one reason which already prime the heart for prolongation.

The reason why the precordium is more vulnerable than the hip also requires further study. It might not just be proximity to the heart.

Concerning the dispersions, the elongations were absent when the dispersions were considered even in hypertensive patients. Familoni *et al.* also earlier noted the discordancy in elongation of QTc and dispersion and has suggested that the factors that elongate QT might not exactly be the same as those that elongate dispersion.[16]

In this study, whereas QTc intervals were longest on the precordium, the dispersion parameters tended to be longer in the hip for all phone positions and modes. It is not clear why this is so.

Hanniet *et al.*[21] have reported hypersensitivity to radiations from laptops and mobile phones and suggest the effects might be due to EM effect on the sympathetic nervous system. The subjects in this study were exposed to the radiation for a short period of 40 secs ringing and the effects might not be due to non-thermal biological effects.

CONCLUSION

The conclusion of this study is that acute short exposure to radiofrequency EM emitted from mobile phones does not generally prolong the QT intervals particularly in normotensive individuals. There was however significant increase in the QT intervals in hypertensive patients and the increase was more with the phone ringing on the precordium rather than the hip. These elongations were not associated with dangerous ventricular arrhythmias.

It is suggested that the phone might be better kept in the hip rather than chest pocket particularly in hypertensive patients.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

MP: Mobile Phone.

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