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RESEARCH ARTICLE

EFFECT OF CELLULAR PHONE USE ON FETAL MONITORING AND UMBILICAL ARTERY DOPPLER

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ABSTRACT

Background: Cell phones have become an integral part of our daily lives. Several studies have shown that non-thermal electromagnetic radiation, such as that generated by mobile phones, may have a physical effect on target cells or tissues, including the embryo. Objective: This study aimed to evaluate the impact of mobile phone use on FHR trace and umbilical artery Doppler as an indicators for fetal surveillance. **Patients and methods:** This study was conducted in Alzahraa university hospital from May 2019 to December 2019, one hundred seventy five low risk pregnant women, 32-40 weeks in gestation. First all participants were instructed not to use their mobile phone for 24 hours prior to the initial CTG trace and Doppler ultrasound. They were then assessed twice for both the CTG non-stress test and umbilical artery Doppler. First measure was performed for the subjects prior to use their cellular phone, and the second measure was repeated 5 min after hanging up their mobile phones which lasting in dialing modes for 10 min. The recorded fetal heart rate (FHR) strips and umbilical artery Doppler findings, before and after mobile phone use collected and statistically analyzed. With concerns and comments on CTG parameters in terms of, baseline fetal FHR, acceleration, deceleration and beat to beat variability with using score for each of them. **Results:** There was insignificant decrease in mean score of basal FHR in women after mobile phone, 3.13 ± 0.76 compared to before mobile phone use, 3.25 ± 0.63 , with $p > 0.05$. However, there was statistically significant decrease in mean acceleration and variability score in women after mobile phone, versus before mobile use, 1.37 ± 0.51 versus 1.64 ± 0.61 , p value < 0.001 and 2.30 ± 0.66 compared to 2.51 ± 0.54 , p -value < 0.05) respectively. There was no deceleration found in both occasions. Regarding umbilical artery blood flow findings, there was no statistically significant difference of PI in women after and before mobile phone use, p -value (> 0.05). While there was statistically significant increase mean of RI and S/D ratio in women after mobile phone, (0.57 ± 0.08 and 2.39 ± 0.28 respectively) compared to those before mobile phone use, (0.55 ± 0.14 and 2.29 ± 0.53 respectively) with p -value (< 0.05). **Conclusion:** Evident from the current study, we concluded that the electromagnetic fields emitted from mobile phone influence the FHR patterns and fetal perfusion.

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INTRODUCTION

Cellphones have become an indispensable part of daily life. They work by creating an electromagnetic field, Therefore there is concern about the long-term effects of exposure and their safety particularly when used during pregnancy (Nageswari, 2015). In Egypt, the most common access method is time division multiple link, which is also used in the global wireless network. This system used a carrier in the 800-900Mz spectrum zone (Moustafa, 2005).

According to some research, cell phone electromagnetic radiation interferes with the brain's signalling mechanism, and thus plays a role in a variety of diseases such as dementia and cardiovascular disease. Furthermore increased usage of cell phones around the world could be linked to an increase in leukaemia and brain tumour prevalence (French, 2001; Knave, 2001; Rezk, 2008). In spite of the fact that American College of Obstetricians and Gynecologists (ACOG) (NICE, 2017) does not have clear recommendations on mobile phones during pregnancy as well as the World Health Organization (WHO) states that mobile phone use has caused no adverse health

effects, However, some studies suggest that non-thermal electromagnetic radiation released by cell phones may have biological effects in human and animal embryo, also other study linked association of certain adverse outcomes especially unexplained ones such as unexplained preterm labor, perinatal hypoxia, fetal distress and death with EMFs exposure (Houston, 2018; Saadia, 2018). Furthermore, some studies have shown that when women use their cellphones excessively during pregnancy, their children are more likely to have behavioural and emotional problems, especially hyperactivity some studies reported that women used cellular phone in excess during pregnancy, their children were more likely to have behavioural and emotional issues, especially hyperactivity. FHR is a useful indicator of fetal well-being in the womb, and it can be measured using a CTG that monitors FHR and can assist in the identification of fetal hypoxia. Doppler sonography also offers a vital opportunity to investigate fetal hemodynamics (Veterany, 2001; Agamy, 2017). It has been proposed that cell phones influence the Fetal heart rate (FHR) and cardio vascular system (Rezk, 2008; Zaheera, 2018). This study aimed to evaluate the impact of mobile phone use on FHR trace and umbilical artery Doppler as an indicators for fetal surveillance.

PATIENTS AND METHODS

This observational cross section study, which carried at, department of obstetrics and gynecology, Alzharaa University Hospital Cairo Egypt from May 2019 to December 2019 on 175 pregnant women after they met inclusion criteria. The included women were, low risk with singleton pregnancy, 32-40 weeks gestation. While patients with; medical disorders or obstetric complications, anomalies of fetus, twins pregnancy and women in labour were excluded from this study. These following steps were established for all participants to fulfill inclusions criteria; complete history, full examination, US was done to detect viability, gestational age, number of fetuses, amount of liquor. The participants instructed to stop the use of mobile phone for 24 hours before their submission to initial CTG trace and Doppler US. Single mobile phone was used (Infinix hot 5). Initially patients with non reassurance fetal CTG trace or high umbilical artery resistance index (RI) were excluded. All participants underwent CTG without mobile phone (controls) and then exposed to mobile phone in calling mode (served as cases) for 10 minutes in a separate room where no other mobile phone was placed. All women underwent to CTG monitor that performed by the same machine (pionet FC700) for 20 minutes, followed by using Doppler transabdominal ultrasound with high resolution 3.5 MHZ, using color Doppler ultrasound (LOGIQv5 ultrasound) spectral traces was obtained from the umbilical cord free loop. The angle of insonation was held between 0 and 60 degrees. The PI and RI were manually and automatically measured over three cardiac cycles. Before and after cell phone use, registered FHR sheets and umbilical artery RI and PI were collected and statistically analysed, with comments on CTG parameters in terms of standard baseline FHR, which ranged from 110-160 b/m. Temporary increases in FHR above baseline of more than 15 beats/minute and lasting more than 15 seconds were described as acceleration. The word "deceleration" refers to a decrease in FHR under the base line, more than 15 b/ m and sustained greater than 15 sec. all participants provided a 1 if there was no deceleration and a 0 if there was. Beat to beat variability is determined as temporary oscillations of FHR between 5-15 b/m (Gagnon, 2003). a six-point scale, the

participants' baseline FHR scores were determined (1 = 110-120, 2 = 121-130, 3 = 131-140, 4 = 141-150, 5 = 151-160, and 6 = 161 and above). A three-point interval scale (where 1 = absent, 2 = 1-3, and 3 = more than 3), response parameters for participants' acceleration score were calculated. The scores calculated on a 0-3-p scale were used to categorise the participants. variability where (0) = Null, variability with undetectable amplitude range, (1) minimal, FHR variability with an amplitude range of five or fewer bpm, (2) moderate, FHR variability with an amplitude range of 5 to 15 bpm, and (3) Good, FHR variability with an amplitude extended more than 25 b/m. Data was gathered and entered into correctly formatted Microsoft Excel worksheets.

Sample size calculation: According to a previous study conducted by Saadia and Farrukh (8), participants with cell phones had substantially lower variability scores (2.522 0.503) as opposed to those without a mobile phone (2.725 0.450) The total sample size required for this study was determined to be 174 cases (87 cases in each group) after adjusting the confidence interval to 95%, the margin of error agreed to 5%, the power of the test to 80%, and the ratio between groups to 1:1.

Statistical analysis: Twenty % (SPSS Inc., Chicago, Illinois, USA). The mean, standard deviation (SD), standard error (SE), and mean difference were used to express quantitative results. When comparing similar samples, a paired sample t-test of significance was used. The confidence interval was calculated statistically: The statistical package for social sciences, version 95 percent, was used to analyze the results, and the appropriate margin of error was set to 5%.

RESULTS

Table (1) this table shows that ,the age of the studied group was ranged from 20 to 30years old and 28.57% of them have primary education ,40% secondary education and 31.43% were college graduates, 34.29% of them were PG and 65.71% were G2 and more, 52.86% women were worker and 37.12% were house wife. Table (2) shows that, there was a statistically insignificant decrease in mean score of basal FHR in pregnant women after mobile phone, 3.13 ± 0.76 compared to before mobile phone use, 3.25 ± 0.63 , with $p > 0.05$. However, there was statistically significant decrease in mean acceleration score, 1.37 ± 0.51 and variability score, 2.30 ± 0.66 in women after mobile phone, versus before mobile use, 1.64 ± 0.61 , and 2.51 ± 0.54 respectively with $p\text{-value} < 0.001$ Regarding the deceleration, the latter was not found in both occasions.

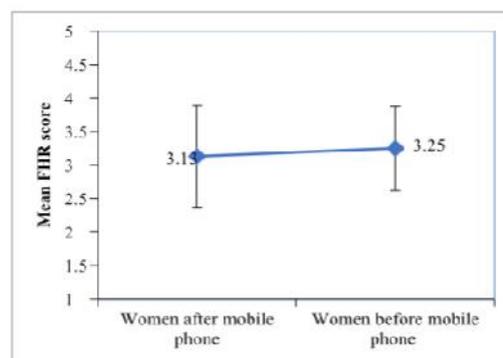


Fig. 1. Mean plots of participant's fetal heart rate scores in women before and after mobile phone use

Table 1. Demographic data of the study group

	N	%
Age (years)		
(20-25)	100	57.14
(25-30)	50	28.57
(30-35)	25	14.29
Education		
Primary	50	28.57
Secondary	70	40
College	55	31.43
Gestational age		
PG	60	34.29
G2and more	115	65.71
OCCUPATION		
House wife	65	37.14
Worker	110	62.86

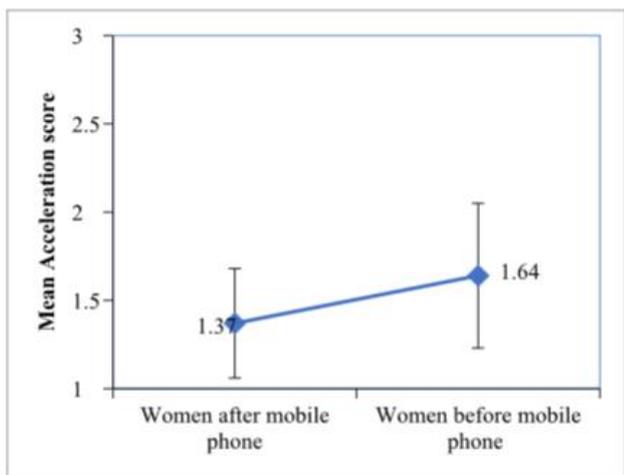


Fig. 2. Mean plots of fetal acceleration scores in study group before and after mobile phone use

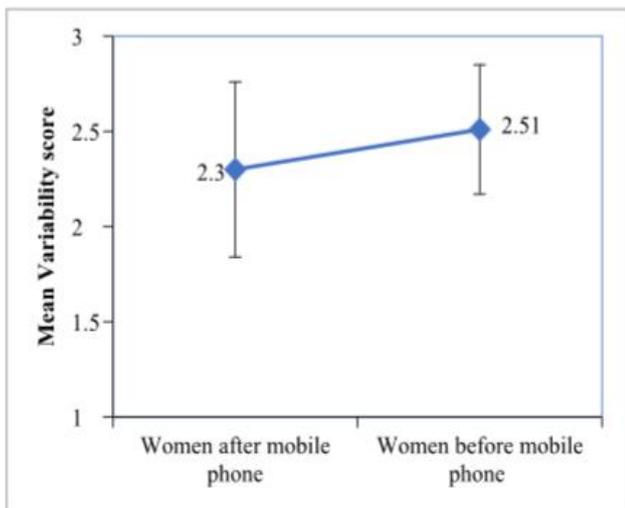


Fig. 3. Mean plots of fetal variability scores in study group before and after mobile phone use

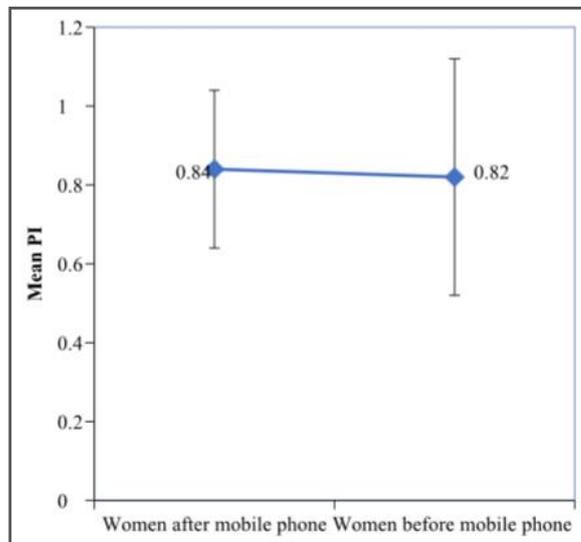


Fig. 4. Mean plots of fetal UAPI in a study group before and after mobile phone use

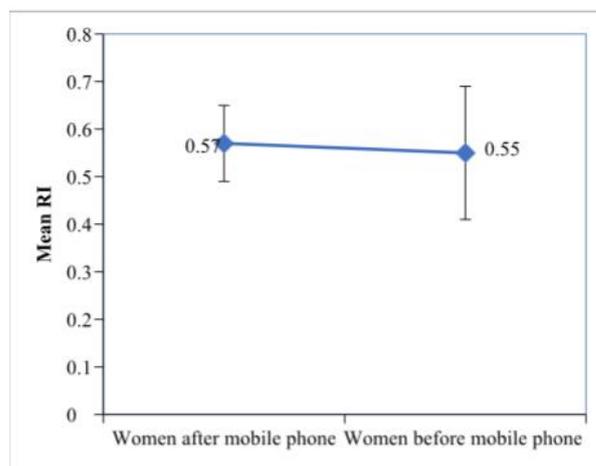


Fig. 5. Mean plots of fetal UA RI in the participants before and after mobile phone use

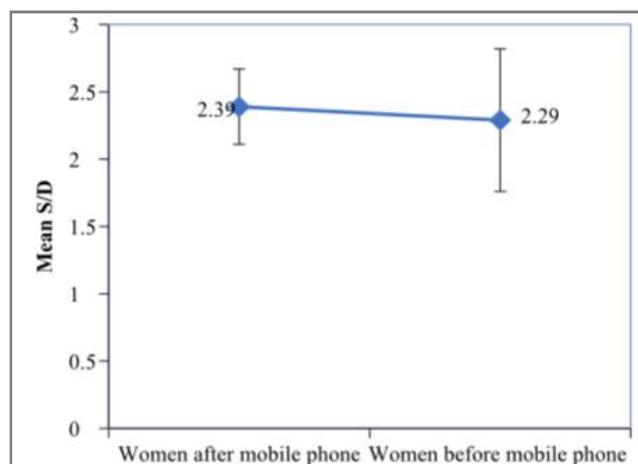


Fig. 6. Mean plots of fetal S/D in the study group before and after mobile phone use.

Table (3) shows that, there was no statistically significant difference regarding the UAPI in the pregnant women after and before mobile phone use, with p-value (>0.05). While there was a statistically significant increase the mean of UARI and S/D ratio in women after mobile phone, (0.57±0.08 and 2.39±0.28 respectively) compared to before mobile use (0.55±0.14 and 2.29±0.53 respectively) with p-value (<0.05).

DISCUSSION

Anatomically, the fetus may be in direct contact with the Cell Phone during transport and use. As a result, EMFs emitted by cellular phones can change nerve conduction and cardiac contractility, affecting FHR patterns (Vadeyar, 2000).

Table 2. Comparison regarding CTG traces in study group before and after mobile phone use

CTG	after mobile phone (N=175)	before mobile phone (n=175)	Paired sample t-test				
			Mean Diff.	±SD	SE	t-test	P-value
FHR score	3.13±0.76	3.25±0.63	0.12	0.38	0.029	1.608	0.108
Acceleration score	1.37±0.51	1.64±0.61	0.27	0.57	0.043	4.492	<0.001**
Deceleration score	1.00±0.00	1.00±0.00	0.00	0.00	0.00	0.000	1.000
Variability score	2.30±0.66	2.51±0.54	0.21	0.79	0.060	3.258	0.002*

Using: Paired Sample –t-test

P value > 0.05 NS; * P value < 0.05 S; ** P-value < 0.001 HS

Table 3. Comparison in the study group regarding the umbilical artery Doppler blood flow before and after mobile phone use

CTG	after mobile phone (N=175)	before mobile phone (n=175)	Paired sample t-test				
			Mean Diff.	±SD	SE	t-test	P-value
PI							
Range	0.57-1.35	0.26-1.42	0.019	0.377	0.028	0.684	0.495
Mean±SD	0.84±0.20	0.82±0.30					
RI							
Range	0.43-0.82	0.17-0.80	0.027	0.154	0.012	2.295	0.023*
Mean±SD	0.57±0.08	0.55±0.14					
S/D							
Range	1.77-2.80	1.21-2.96	0.105	0.605	0.046	2.290	0.024*
Mean±SD	2.39±0.28	2.29±0.53					

Because determining fetal well-being during pregnancy is a contentious issue, the use of cell phone radiation as a potential endorser of foetal distress and possible foetal hypoxia was described as the main focus (Saadia, 2018). During this study, One hundred ninety five patients were assessed for eligibility and One hundred seventy five patients were included in the study. Of all eligible patients, 20 patients were excluded from the study based on the inclusion criteria and refusal of the study. Ultimately, the analysis was done based on the data of 175 patients who approved to participate in the study with age 18-40 years old, low risk with singleton pregnancy, 32-40 weeks gestation and BMI < 30. In the current study regarding FHR pattern changes, our research study, revealed that pregnant women after mobile phone dialing had statistical insignificant difference in basal FHR compared to those before mobile use ($p > 0.05$) while there was significantly decreased FHR variability scores (p -value < 0.05) and decreased FHR accelerations scores in pregnant women after mobile phone use when compared to those before mobile phone use (p -value < 0.001). Both the parasympathetic and sympathetic branches of the autonomic nervous system modulate cardiovascular function, especially HR and heart rhythmicity, and are tonically active in regulating heart function. The cumulative influence of activity in certain regions in the medulla and hypothalamus is responsible for the tonic activity of the autonomic nervous system in the cardiovascular system (Veliks *et al.*, 2004). vasomotor region in the medulla is made up of a pressor area that keeps tonic sympathetic outflow to the bloodstream going and a depressor area that keeps the pressor area from doing so. When activated, the cardio inhibitory region of the medulla increases parasympathetic activity while decreasing sympathetic activity to the heart, lowering heart rate and myocardial contractility (Veliks *et al.*, 2004). The fetal heart rate changes in our study attributed to, exposure of EMFs may induce direct toxic effect on cardiac muscle, which was proposed by Fadel *et al.* (2003) who found that, ECG recording from rats exposed to EMFs showed a significant change. The authors discovered an abnormal pattern in QRS complexes in the ECG, which could suggest cardiac muscle destruction and/or local blocks in Purkingi fibre impulse conduction.

Another alteration was a drop in p wave amplitude as a result of cardiac myopathies triggered by myocardial infarction and diastolic dysfunction (Rezk, 2008). Saadia (2018) conducted a study involved Sixty-nine women, to investigate the impact of mobile phone exposure on FHR in obese women (BMI > 30 Kg/m²) and non-obese women (BMI = 30 Kg/m²). Regarding the basal FHR, the authors were in keeping with our results, they revealed that was no statistically significant difference in basal FHR of pregnant women with or without mobile phones dialing, (p value=0.507). But regarding the variability, the previous authors, Saadia (Saadia, 2018) observed a significant increase in the variability score from 1.28 to 1.53 in non-obese women with mobile phones (p value=0.017). Rezk *et al.* (2008) reported that there was a statistically significant increase in foetal FHR with cell phone usage after acute maternal exposure to EMF emitted by mobile phones during dialling mode for 10 minutes. Farid *et al.* (2009) conducted study involved three hundred and fifty eight low risk pregnant women (28-32 weeks in gestation) underwent to cardiotocography (CTG) monitoring and Doppler ultrasound evaluation twice, during the mobile phones switched off and repeated in dialing mode. The authors revealed that CTG findings showed a significant higher basal FHR while the electromagnetic field was generated from mobile phone than when the phone was switched off (p value= 0.01), while they revealed no increased in accelerations of FHR when the mothers were talking on the mobile phones. Also, Celik *et al.* (2004) investigated the effects of electromagnetic fields emitted by cellular phones on FHR pattern in a study included 40 volunteers with uncomplicated pregnancies, and they found that there were no significant differences in any of the CTG parameters (basal FHR, accelerations and deceleration FHR scores). In contrast to our results, Rezk *et al.* (2008) reported increased basal FHR after maternal use of mobile phones and they explained that by stimulation of the fetal cardio-accelerating area in the hypothalamus (Veliks *et al.*, 2004). This Controversy may be attributed to small samples size of some previous studies, in addition, other study involved younger gestational age less than 32 weeks, the fetuses in this age didn't have complete developed Autonomic nervous systems.

Regarding umbilical artery Doppler changes, our results revealed that, there was statistically significant increase in umbilical artery resistance index (UARI) in fetuses of pregnant women after mobile phone use compared to whom before mobile use (p value= 0.023). Similarly there was statistically significant increase in S/D ratio after mobile phone use compared to before use (p value=0.024). While there was no statistically significant difference before and after use of mobile phone in pulsatility index (PI) among participants (p value= 0.495). Our result was consistent with Rezk *et al.* (2008) who observed the cardiac output (COP) changes following acute maternal exposure to EMF and they showed that significant reduction of End Diastolic Volume, End Systolic Volume, and Stroke Volume and Cardiac Output. The decrease of fetal perfusion after mobile phone use can be explained mainly by the decrease in cardiac contractility as a result of direct toxic effect of EMFs on cardiac muscle, failure in the metabolic activity of the red blood cells which resulted by magnetic fields of which leading to decrease of RBC membrane elasticity and permeability, and changes in the molecular structure of hemoglobin and alteration in calcium channels (Ca²⁺) homeostasis (Li, 2015). On the other hand, Farid *et al.* (2009) inconsistent with our results, they revealed no detectable differences in the fetal perfusion detected by Doppler resistance index (RI) of the umbilical artery (p value= 0.32). In spite of the authors conducted their study on large size of population {n=385}, but they used younger gestational age. Ultimately, we ask a question: Are these CTG and Doppler changes temporary? And if these changes are temporary, do these changes with time and repeated use of the mobile phone, become permanent and in turn affect the baby's CVS, placental perfusion and oxygen supply?. Moreover, Can these changes produce miss interruption of antenatal or intrapartum fetal monitoring of mothers that use mobile phone during monitoring or just after monitoring and consequently we be careful to avoid the use of cellular phone in obstetric ward, all these questions are required further studies to be answered. The strength point of this study that, it is the first study to evaluate the effect of electromagnetic fields emitted from the mobile phone on FHR and fetal perfusion in Al-zahraa Hospital which may contribute to decrease the unindicated emergency delivery based on abnormal CTG pattern or umbilical artery Doppler changes. Secondly, larger sample size related to the previous studies, being a multi-centric study. The limitations of the study, we did not evaluate the antenatal and postnatal cardiac function by fetal echo which may explain more changes. Second limitation is the limited available researches about the effect of EMFs on Doppler blood flow.

CONCLUSION

Evident from the current study, we concluded that the electromagnetic fields emitted from mobile phone influence the FHR patterns and fetal perfusion. So we recommend some advice for pregnant women, using mobile as least as possible and keeping any mandatory calls short. Instead of making calls on mobile, send a text or use a landline. Avoid putting phone in your pocket that is too close to your pregnant belly, and avoid putting it under your pillow, Switch off the WiFi when you've gone to bed or when you're not using it. This study was conducted according to the guideline of declaration of Helsinki 2013, and approved by the ethical committee of the faculty of medicine for Girls, Cairo, Al Azhar University, (approval no,

202101592). Informed written consent was taken from all participants before enrolling the study

Availability of data and material: Not applicable

Competing interests: Authors declared that they have any conflict of interest.

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