THE EFFECT OF ELECTROMAGNETIC FIELD ON FETAL CARDIAC OUTPUT

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Abstract

The use of cellular (mobile) phone has been exploded worldwide during last decade. Their rapid adoption by general public has resulted in an increased research interest in possible harmful health effects (Tahvanainen et al., 2004). This common use of cellular phones has given rise to concerns about the potential influences of electromagnetic fields on human physiology (Croft et al., 2002).

We studied the effect of electromagnetic fields emitted by cellular phone on fetal heart rate patterns, end diastolic volume, end systolic volume, stroke volume and cardiac output.

Our results showed that after use of mobile phones on different gestational ages (group I, II & III), significant increase in FHR and significant reduction of EDV, ESV, SV & Cop. The percent of reduction in EDV was more than the percent of reduction in ESV in all groups. This prominent decrease in EDV more than the decrease in ESV suggests that the decrease in SV is mainly due to decrease in contractility.

We conclude that the use of mobile phone has a negative effect on fetal heart so we recommend avoidance of cellular phone use especially in the early weeks of gestation and if necessary, the phone call should be less than ten minutes.
Introduction

During recent years mobile communication systems have experienced wide and rapidly growing use all over the world (Hossmann and Hermann, 2003). The use of cellular (mobile) phone has been exploded world wide during last decade. Their rapid adoption by general public has resulted in an increased research interest in possible harmful health effects (Tahavanainen et al., 2004). This common use of cellular phones has given rise to concerns about the potential influences of electromagnetic fields on human physiology (Croft et al., 2002).

There are only a few human studies concerning the cardiovascular effects of radio frequency fields during mobile phone use and the results have been controversial (Branune and Wrocklage, 1998; Branune et al., 2002).

Anatomically, the fetus may be in close proximity to cellular phone during transport and use; therefore electromagnetic fields emitted from cellular phone may lead to fetal cardiovascular effects (Vadeyar et al., 2000).

This suggestion directed our attention to design this work in which we studied the effect of electromagnetic fields emitted by cellular phone on fetal heart rate patterns, end diastolic volume, end systolic volume, stroke volume and cardiac output.

Subjects and Methods

Subjects:

This study was conducted in Benha University Hospital during the period from October, 2002 to October, 2003. 30 women with uncomplicated pregnancies aged from 18 to 33 years old agreed with written consent to share in this work.

Groups of the study:

Subjects were classified into 3 groups, ten subjects each:

Group I: gestational age of pregnancy ranging from 25 to 30 weeks.

Group II: gestational age of pregnancy ranging from 31 to 35 weeks.

Group III: gestational age of pregnancy ranging from 36 to 40 weeks.

The effect of electromagnetic fields emitted by mobile phone during a telephone lasting for a period of time by each pregnant women studied on the following parameters:

- Fetal heart rate (FHR)
- Fetal heart rate deceleration and duration
- Fetal end diastolic volume
- Fetal end systolic volume
- Fetal stroke volume
- Fetal cardiac output

Methodology:

All cases were subjects:

a. Clinical history:

Women with past histories of using the mobile phone were excluded from the study.

b. Ultrasonographic examination using Aloka SSD 720 - LTD - TOKYO - Japan:

- Confirmation of the gestational age using the biparietal diameter and femur length
- Fetal lie and presentation

Fetuses with presentation other than cephalic were excluded from the study.

c. Fetal heart rate (FHR)
fields emitted by mobile telephone during a telephone conversation lasting for a period of 10 minutes by each pregnant woman was studied on the following fetal parameters:

- Fetal heart rate (baseline, acceleration and deceleration).
- Fetal end diastolic volume.
- Fetal end systolic volume.
- Fetal stroke volume.
- Fetal cardiac output.

**Methodology:**

**All cases were subjected to:**

a. Clinical history:
   Women with past history of using the mobile phone were excluded from the study.

b. Ultrasonographic examination using (Aloka Sector Scan SSD 720 - Aloka Co. LTD - TOKYO - JAPAN) to check for:
   - Fetal lie and presentation.
   - Confirmation of the gestational age using the biparietal diameter and femur length.

Fetuses with presentations other than cephalic were excluded from the study.

c. Fetal heart rate (FHR) recording:
   A full 20 minutes of fetal heart rate recording using an electronic FHR monitor (Sonicaid LTD. Model Fm7L, Chichester, England) was performed for all cases (Divon et al., 1985).

- The Doppler mode was used with a paper speed of one cm/minute.

- The FHR recording was performed while the patients were holding a mobile phone of GSM 900 type (Global System for mobile communication at 900 MHZ) (Nokia : 6510, Type : NPM-9) on the right - hand side of the head in a typical telephoning position on stand - by mode and then on dialing mode, each for 10 minutes (Celik and Hascalik, 2004).

- The FHR analysis was based on the description of heart rate patterns regarding baseline heart rate, accelerations and decelerations.

**Baseline FHR**: the modal rate that prevails apart from any accelerations or decelerations associated.
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ed with uterine contractions or fetal movements. Value ranging from 120-160 bpm (beat per minute).

FHR accelerations: the transient increase in fetal heart rate in excess of 15bpm from the baseline for more then 15 seconds.

FHR decelerations: the transient decreased in fetal heart rate in excess of 15bpm from the baseline for more than 15 seconds.

d. Fetal cardiac output recording:

Fetal cardiac output recording using Doppler echocardiography (Toshiba SSH-140A color Doppler, continued and pulsed, power-Japan) was performed for all cases:

* The fetal cardiac output recording was performed while the patients were holding a mobile phone of GSM 900 type (Global System for mobile communication at 900 MHZ) [Nokia, Model : 6510, Type : NPM-9], on the right-hand side of the head in a typical telephoning position on stand-by mode and then on dialing mode.

Results

There was a reduction in the percent of decrease in EDV and ESV as the gestational age increase. The percent of reduction in EDV was more than the percent of reduction in ESV in all groups denoting that the reduction in the SV is mainly due to the reduction in the EDV more than ESV.

The percent of decrease in Cop also showed progressive reduction with increase in gestational age, denoting that the effect of exposure to mobile phone on the Cop become lesser as the gestational age increase.
Table (1): Summary of data analysis (Baseline Fetal heart rate (bpm), Number of accelerations, EDV(ml), ESV(ml), SV (ml), COP(ml/min) before and after use of mobile phone in pregnant women of gestational age ranged from 25-30 weeks.

<table>
<thead>
<tr>
<th></th>
<th>Baseline FHR (bpm)</th>
<th>Number of accelerations</th>
<th>EDV (ml)</th>
<th>ESV (ml)</th>
<th>SV (ml)</th>
<th>COP (ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Mean</td>
<td>124.3</td>
<td>140.6</td>
<td>1.5</td>
<td>1.9</td>
<td>9.1</td>
<td>6.3</td>
</tr>
<tr>
<td>SD</td>
<td>12.9</td>
<td>12.6</td>
<td>0.5</td>
<td>0.6</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>T- value</td>
<td>2.539068</td>
<td>0.96253</td>
<td>2.56732</td>
<td>1.293742</td>
<td>1.929875</td>
<td>2.197321</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.011* Significant increase</td>
<td>&lt;0.7 Non significant increase</td>
<td>&lt;0.003* Significant decrease</td>
<td>&lt;0.02* Significant decrease</td>
<td>&lt;0.001* Significant decrease</td>
<td>&lt;0.025* Significant decrease</td>
</tr>
</tbody>
</table>

Table (1) : Showed significant increase in FHR and significant decrease in EDV, ESV, SV and COP.

Table (2): Summary of data analysis (Baseline Fetal heart rate (bpm), Number of accelerations, EDV(ml), ESV(ml), SV (ml), COP(ml/min) before and after use of mobile phone in pregnant women of gestational age ranged from 31-35 weeks.

<table>
<thead>
<tr>
<th></th>
<th>Baseline FHR (bpm)</th>
<th>Number of accelerations</th>
<th>EDV (ml)</th>
<th>ESV (ml)</th>
<th>SV (ml)</th>
<th>COP (ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Mean</td>
<td>129.5</td>
<td>139</td>
<td>1.5</td>
<td>1.6</td>
<td>11.6</td>
<td>7.1</td>
</tr>
<tr>
<td>SD</td>
<td>17.1</td>
<td>14.2</td>
<td>0.34</td>
<td>0.51</td>
<td>4.1</td>
<td>3.4</td>
</tr>
<tr>
<td>T- value</td>
<td>2.37052</td>
<td>0.367351</td>
<td>3.37278</td>
<td>2.34067</td>
<td>2.247863</td>
<td>1.3810641</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.097 Non significant increase</td>
<td>&lt;0.33 Non significant increase</td>
<td>&lt;0.0003* Significant decrease</td>
<td>&lt;0.05* Significant decrease</td>
<td>&lt;0.05* Significant decrease</td>
<td>&lt;0.015* Significant decrease</td>
</tr>
</tbody>
</table>

Table (2) : Showed significant decrease in EDV, ESV, SV and COP and non significant increase in FHR.