Impact of electromagnetic waves on sperm motility

Samah AboulGheit1, Fatma Elatebi2, Amal Shohyeb1, Ola El Gohary3, Ahmed Hosni1

1Department of Obstetrics and Gynecology, Cairo University, Cairo, Egypt; 2Department of Obstetrics and Gynecology, King Abdulaziz University, Jeddah, Saudi Arabia; 3Department of Physiology, Benha University, Benha, Egypt

Objective: To evaluate the impact of electromagnetic waves emitted by mobile phones on sperm motility in fertile and subfertile men.

Participants: This study was performed in two phases. Phase I included twenty normal (fertile) men and phase II included twenty men with severe oligospermia.

Methods: Semen samples were obtained and subjected to semen analysis. Each sample was divided into two equal parts one was placed close to a mobile phone handset and the other was placed about five meters away. The mobile phone was kept in connection with the mobile phone network every ten minutes for 1 hour. Each semen sample was examined by a separate investigator for motility at three time points: at the start of connection, after 30 minutes, and after 60 minutes. Motility was analyzed statistically.

Results: Normal semen samples close to mobile showed statistically significant improvements when compared to the control for both the total motility and grade C motility after 60 minutes exposure ($P < 0.0001$ and $P = 0.018$, respectively.) Samples with severe oligospermia showed similar findings regarding total motility ($P = 0.004$) but not grade C motility ($P = 0.068$)

Conclusion: This pilot study indicates a possible benefit in the use of electromagnetic waves for stimulating sperm motility, although the exact underlying mechanism is unclear. Further large studies, preferably blinded, are needed to confirm these findings and to investigate the mechanism involved.

Keywords: electromagnetic wave, sperm motility, male infertility

Introduction

The phenomenon of electromagnetic interference by mobile phones is real and potentially clinically significant. The use of mobile phones is widespread and the number of users is increasing so rapidly that mobile phone use now represents one of the most common and fastest growing environmental radiation influences.1 A recent study that monitored the effects of electromagnetic wave exposure on bovine semen showed a significant ($P < 0.001$) decrease in the percentage of motile spermatozoa in experimental groups after 120 and 420 min of culture with exposure to micro-waves, when compared to control cultures. A greater percentage of progressively motile spermatozoa were also similarly inhibited in motility following microwave exposure. Treatment with 1800 MHz radio frequency electromagnetic wave radiation had a negative and time-dependent effect on bovine spermatozoa motility.2 The aim of the present study was to evaluate the impact of electromagnetic waves emitted from mobile phones for over 60 minutes duration on sperm motility in fertile and subfertile human males.
Methods

Study population
The present study was conducted according to the principles expressed in the Declaration of Helsinki. The experiment was performed only on semen portions remaining from samples used for intracytoplasmic sperm injection. All patients provided written informed consent for conducting these experiments using the remaining samples and for subsequent analysis. All samples were subjected to semen analysis. Sexual abstinence prior to the sampling of semen was 2–7 days. Sperm was obtained by the method of masturbation in a selected room near the laboratory.

Procedures
After allowing at least 30 min for liquefaction to occur, spermatozoa were separated from seminal plasma. The isolated spermatozoa were washed, then centrifuged at 600 × g for 15 min, and evaluated for vitality, motility, and cell density. Vitality was determined by transferring 5 μL of each cell fraction onto a microscope slide, followed by addition of 5 μL of 0.5% eosin; the percentage of pink-stained, non-viable cells was then assessed by light microscopy. Motility was assessed by transferring 6 μL of the same sample onto a slide, covering with a coverslip, and examining by phase contrast microscopy. For both the vitality and motility assessments, 100 cells were counted and the results expressed as percentages.

The study included two phases: In Phase I, the semen samples were obtained from twenty fertile men. Samples were divided into 2 equal portions: one was placed close to a mobile phone (∼1 cm) with no other electronic devices nearby, and the other was placed 5 meters away from the phone. Each sample was then examined by a separate investigator for motility. The mobile device connected to the mobile network every ten minutes for 1 hour at room temperature. Motility was evaluated at the start of connection, after 30 minutes of examination, and after 60 minutes of examination. Phase II included semen samples from twenty men with severe oligospermia and the above procedure was repeated.

Statistical methods
Data were expressed as means and the following statistical tests were used in the present study: Students t-test (t-test) to compare between 2 parametric variables and Chi square ($\chi^2$) for comparing non-parametric data. All statistical calculations were performed using Microsoft Excel version 7 (Microsoft Corporation, New York, NY, USA) and SPSS (Statistical Package for the Social Science; SPSS Inc, Chicago, IL, USA) statistical programs.

Results
No significant differences were noted for motility between spermatozoa from samples located away from or close to the mobile phone in the fertile group. In contrast, motility was improved significantly in spermatozoa from samples from men with severe oligospermia (Table 1). Interestingly, exposure of immotile spermatozoa to electromagnetic waves caused a few spermatozoa to initiate shaking movements.

Discussion
Ever since mobile phones first intruded into our lives in the mid-nineties of the last century, concerns about their safety and their potential effects on human health have been constant. Currently, over five billion mobile phones are estimated to be in use worldwide, and that number is still growing. Consequently, mobile phone use likely represents the single most important environmental radiation influence in recent years. Radio-frequency electromagnetic radiation (RF-EMR) is the cause of these health hazard concerns. The effect of RF-EMR on male fertility and the quality of spermatozoa is not known. Several studies have been conducted in order to try to answer this question, yet the debate continues.2–4

A number of studies conducted on rats, mice, and rabbits, have examined mobile phone exposure for variable lengths of time and have reported decreases in both sperm count and motility.2 Erogul and colleagues exposed unprocessed

Table 1 Comparison between study group (close to mobile) and control group (away from mobile)

<table>
<thead>
<tr>
<th></th>
<th>Close to the mobile phone</th>
<th>Away from the mobile phone</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fertile semen</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total motility %</td>
<td>54.31</td>
<td>49.66</td>
<td>10.08</td>
</tr>
<tr>
<td>a</td>
<td>14.48</td>
<td>12.05</td>
<td>8.97</td>
</tr>
<tr>
<td>b</td>
<td>24.31</td>
<td>22.24</td>
<td>8.02</td>
</tr>
<tr>
<td>c</td>
<td>15.52</td>
<td>18.62</td>
<td>7.89</td>
</tr>
<tr>
<td><strong>Severe oligospermia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total motility %</td>
<td>54.83</td>
<td>51.9</td>
<td>16.71</td>
</tr>
<tr>
<td>a</td>
<td>24.48</td>
<td>17.75</td>
<td>12.74</td>
</tr>
<tr>
<td>b</td>
<td>20</td>
<td>8.02</td>
<td>12.03</td>
</tr>
<tr>
<td>c</td>
<td>10.34</td>
<td>5.16</td>
<td>5.61</td>
</tr>
</tbody>
</table>

Notes: a: rapid motility; b: slow motility; c: immotile.
raw spermatozoa to the RF-EMR emitted by an activated cellular phone (900 MHz), and found this exposure to cause a slight decrease in the rapid progressive and slow progressive sperm movement and an increase in the percentage of immotile spermatozoa.3

Another in vitro study compared semen samples from healthy donors (n = 23) and infertile patients (n = 9). After liquefaction, the semen samples were exposed to radiation from a cellular phone in talk mode for 1 h (850 MHz). The distance between the phone antenna and the specimens was fixed at 2.5 cm. Spermatozoa exposed to RF-EMR showed a significant decrease in sperm motility and viability, an increased production of reactive oxygen species (ROS), and a reduced ROS-total antioxidant capacity (TAC) score.4

Agarwal and colleagues suggested that the use of cellular phones adversely affected the quality of semen in 361 men attending an infertility clinic.4 Other investigators showed that the duration of cellular phone possession and the duration of daily transmission correlated negatively with semen quality in 371 men.5 Depinder and colleagues explained the deleterious effects of mobile phone radiation on spermatogenesis, testosterone biosynthesis, and damage to sperm DNA as being a consequence of scrotal hyperthermia and oxidative stress generated by mobile phone exposure.6 The habit of keeping the mobile phone in the trouser pocket or the duration of its use may have an impact on possible generation of hyperthermia and this may alter the optimal temperature of spermatogenesis.

In our study, an explanation for why the RF-EMR from a mobile phone improved the sperm motility in samples from men with severe oligospermia is not readily apparent. However, the negative effect of the mobile phone radiation on spermatozoa due to an increase in temperature of the testicles and hence spermatogenesis in the previous two studies might not be applicable when it comes to direct effects on the spermatozoa rather than on the scrotum. More than one study has shown decreased sperm motility among other parameters in experiments similar to ours.3,4 At the same time, delayed long-term effects are more important in clinical practice than are early effects like improvement in sperm motility, especially considering that motility is not an essential part for fertilization using intracytoplasmic sperm injection. We would suggest that larger scale studies be conducted that can overcome the pitfalls and limitations of the previous studies.

The present study is different from other papers published on effect of cellular phones on semen quality.7–9 First: it was of limited duration (just a few hours of exposure to electromagnetic waves). Second: it studied direct exposure of spermatozoa to electromagnetic waves (ie, with no barrier or interface like tissue or fluids). Third: we focused on motility only, meaning that an immediate effect was examined, rather than delayed or long-term impacts. This could have a potential for selecting which immotile sperm to use in intracytoplasmic sperm injection procedures in the infrequent cases where all sperms are immotile. In the present study, when exposed to RF-EMR, a few immotile sperms initiated shaking movements.

One more advantage of this study is that it avoided the difficulty of assessing the effects of electromagnetic waves on the human body, which has associated ethical aspects. In the case of studies conducted on animals, the problem is of lesser importance, but the results of animal studies cannot be directly translated to the human body. One limitation of our study is that it did not examine other effects of mobile phones on sperm functions, such as DNA fragmentation and ROS production (oxidative stress).

Conclusion
In conclusion, the results of this pilot study show that one effect of electromagnetic waves may be to stimulate sperm motility. However, the exact mechanism is unclear. Further large studies, preferably blinded, are needed to confirm these findings and to investigate the mechanism involved.

Disclosure
The authors report no conflicts of interest in this work.

References
