

ORIGINAL ARTICLE

Impact of cell phone use on men's semen parametersT. Gutschl¹, B. Mohamad Al-Ali¹, R. Shamloul², K. Pummer¹ & H. Trummer¹¹ Medical University of Graz, Graz, Austria;² Queen's University, Kingston, ON, Canada**Keywords**

Follicle stimulating hormone—luteinising hormone—prolactin—radiofrequency electromagnetic waves—testosterone

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Summary

The objective of the present retrospective study was to report our experience concerning the effects of cell phone usage on semen parameters. We examined 2110 men attending our infertility clinic from 1993 to October 2007. Semen analysis was performed in all patients. Serum free testosterone (T), follicle stimulating hormone (FSH), luteinising hormone (LH) and prolactin (PRL) were collected from all patients. The information on cell phone use of the patients was recorded and the subjects were divided into two groups according to their cell phone use: group A: cell phone use ($n = 991$); group B: no use ($n = 1119$). Significant difference was observed in sperm morphology between the two groups. In the patients of group A, 68.0% of the spermatozoa featured a pathological morphology compared to only 58.1% in the subjects of group B. Patients with cell phone usage showed significantly higher T and lower LH levels than those who did not use cell phone. No significant difference between the two groups was observed regarding FSH and PRL values. Our results showed that cell phone use negatively affects sperm quality in men. Further studies with a careful design are needed to determine the effect of cell phone use on male fertility.

Introduction

Cell phones operate using a wide range of frequency bands (400–2000 MHz) and which emits radiofrequency electromagnetic waves (EMW). A number of studies reported several potential unpleasant effects of the radiofrequency EMW on different body organs, including the brain and heart (Huber *et al.*, 2000; Sandstrom *et al.*, 2001; Braune *et al.*, 2002; Oktem *et al.*, 2005). Moreover, other studies reported that extensive usage of cell phones may lead to sleep disturbances, fatigue and headache (Ofstedal *et al.*, 2000). The potential undesirable effects of radiofrequency EMW on the male reproductive system are not well known.

According to Sharlip *et al.* (2002) and Thonneau *et al.* (1991), approximately 15% of married couples are infertile. Infertility is defined as inability to conceive after a year of sexual intercourse without the use of contraceptives. In 50% of the cases infertility is due to the male factor. Causes of male infertility may be congenital or acquired. Acquired causes include infections, trauma or

exposure to toxic environmental factors. These causative agents may be chemical substances, ionising radiation, stress, as well as electromagnetic waves (Petrelli & Mantovani, 2002; Sheiner *et al.*, 2003; Claman, 2004).

The potential adverse effects of cell phone technology on male fertility were extensively investigated in the past 3 years by many researchers who reported significant adverse effects on seminal parameters, including motility and morphology (Erogul *et al.*, 2006; Wdowiak *et al.*, 2007; Agarwal *et al.*, 2008, 2009). Other animal studies demonstrated that EMW may have a broad range of damaging effects on the male reproductive functions through both thermal and nonthermal effects (Aitken *et al.*, 2005). The objective of the present retrospective study was to report our experience concerning the effects of cell phone usage on semen parameters.

Methods

In this retrospective study, we examined 2110 consecutive men attending our infertility clinic from 1993 to 2007.

The mean age of the study population was 31.6 ± 6.6 years. Exclusion criteria were patients with a history of smoking or alcohol consumption and those with systemic diseases, orchitis and varicocele. Semen samples were collected by masturbation after an abstinence period of 3–5 days. Semen analysis was performed according to World Health Organization guidelines (1992 and 1999). Serum free testosterone (T), follicle stimulating hormone (FSH), luteinising hormone (LH) and prolactin (PRL) were collected from all patients. The information on cell phone usage of the patients was recorded and subjects were divided into two groups according to their cell phone usage: group A: cell phone use ($n = 991$); group B: no use ($n = 1119$).

Statistical analysis was performed using multivariate analysis of variance (MANOVA). Differences between the two groups were considered significant when the significance level (P) was <0.05 .

Results

All assessed parameters correlated negatively with the use of cell phones (Table 1). A significant difference was observed in sperm morphology between the two groups (Fig. 1). In the patients of group A, 68.0% of the spermatozoa featured a pathological morphology compared to only 58.18% in the subjects of group B ($P < 0.0001$).

Teratozoospermia (abnormal sperm morphology) was diagnosed in 45.3% of the cell phone users versus 27.7% of the patients who do not use cell phones. The proportion of rapid progressive motile spermatozoa was also significantly decreased in group A: 23.98% versus 25.19% in group B. ($P < 0.01$).

No significant difference was observed regarding sperm count. Cell phone users showed a mean sperm count of 62 million spermatozoa ml^{-1} versus 65.7 million ml^{-1} in group ($P < 0.186$).

Concerning hormonal profile, patients with cell phone usage showed significantly higher T (Fig. 2) and lower

LH-levels than those who did not use cell phones. No significant difference between the two groups was observed regarding FSH and PRL values.

Discussion

It is estimated that approximately 700 million people use cellular phones on a daily basis. This extensive and regular exposure to EMW carries many potential health hazards which were investigated in the medical literature. To date there is no conclusive evidence regarding detrimental effects of cell phone usage on male fertility.

We confirmed the previous reports on the detrimental effects that cell phones have on male reproductive functions. Fejes *et al.* (2005) evaluated 371 men undergoing infertility assessment regarding their daily usage of cell phones and reported daily transmission times of cell phones correlated negatively with the proportion of rapid progressive motile spermatozoa. Davoudi *et al.* (2002) showed that using GSM phones for 6 h day^{-1} for 5 days decreased the rapid progressive motility of spermatozoa. Moreover, in a more recent study Agarwal *et al.* (2008) reported that not only sperm motility decreased with cell phone usage, but also sperm viability and morphology were significantly reduced. They reported that these four sperm parameters decreased in all four cell phone user groups as the duration of daily exposure to cell phones increased. Our results confirmed the observations of the above-mentioned studies; there was a significant reduction in the semen quality of men using cell phones, including sperm motility and morphology. It seems that exposure to EMW through cell phones does not affect total sperm count which may indicate that certain testicular functions are still preserved.

The mechanisms of the detrimental effects of cell phone use are not yet known (Makker *et al.*, 2009). Three main mechanisms were hypothesised to explain the effects of EMW on male reproductive functions, namely, (i) an EMW-specific effect; (ii) a thermal molecular effect; or

Table 1 Characteristics of semen parameters and hormonal profile of infertile men using (group A) and not using cell phones (group B)

	Group A ($n = 991$)	Group B ($n = 1191$)
Sperm count (million ml^{-1})	62	65.7
Sperm motility (% rapidly progressive)	23.9*	25.1
Sperm morphology (pathologic spermatozoa)	68%*	58%
Abnormal sperm morphology (teratozoospermia)	45.3%	27.7%
T (N : 3–21 ng dl^{-1})	$5.1 \pm 1^*$	4.8
LH (N : 2–18 mIU ml^{-1})	$3.3 \pm 2^*$	4.1
FSH (N : 1–18 mIU ml^{-1})	5.2 ± 3	5.4
PRL (N : <20 ng ml^{-1})	12.2 ± 10	12.3

FSH, follicle stimulating hormone; LH, luteinising hormone; PRL, prolactin; EMW, radiofrequency electromagnetic waves; T, testosterone.

* $P < 0.05$.

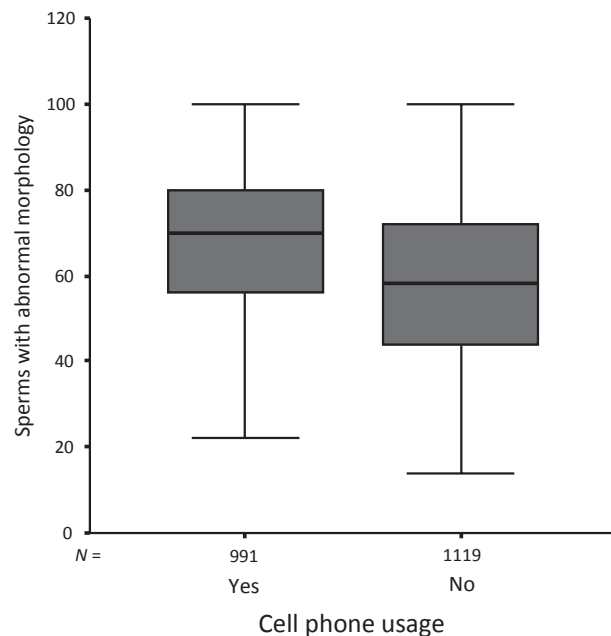


Fig. 1 Effects of cell phone usage on sperm morphology.

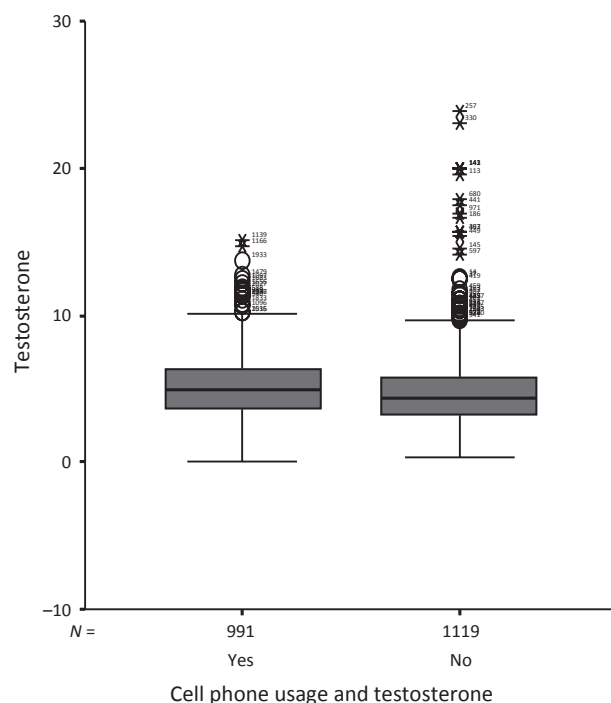


Fig. 2 Effects of cell phone on testosterone.

(iii) a combination of these two factors. These effects may lead to disruption of spermatogenesis, sperm chromatin and sperm DNA damage (Agarwal *et al.*, 2008). Data from our study indicated that other mechanisms might be involved in the EMW actions on male reproduction.

In this study, we evaluated the serum levels of the well-known fertility-related hormones (T, LH and FSH as well as PRL). Djeridane *et al.* (2008) reported that EMW seem to have no effects on hormonal functions. Because of the small number of patients ($n = 20$) who were exposed to EMW for a short duration. In contrary to his results, we report significantly higher T and lower LH levels in our patients who used cell phones. Although the difference of absolute T values between both groups is marginal, a more intriguing explanation is that EMW may have resulted in Leydig cell hyperplasia leading to higher levels of T but with reduced reproductive functions.

Leydig cells are polygonal, eosinophilic cells with a round vesicular nucleus which contain lipid droplets and are found adjacent to the seminiferous tubules in the testis (Al-Agha & Axiotis, 2007). They secrete T, androstenedione and dehydroepiandrosterone, when stimulated by LH. T performs a wide variety of physiological actions itself (Weinbauer *et al.*, 2001) or after being converted to its more potent derivative dihydrotestosterone by the enzyme 5- α reductase or after being aromatised to oestradiol by the aromatase enzyme. Therefore, EMW may have inhibited 5- α reductase enzyme leading to higher levels of the former. This explanation (Zhu & Imperato-McGinley, 2009) is especially appealing as dihydrotestosterone has an important role in maintaining normal epididymal functions concerning sperm maturation and motility. EMW may have altered the activity of the aromatase enzyme, leading to more T and less oestradiol. While no conclusive statements could be obtained from our study concerning the mechanisms by which EMW affect male reproductive functions, these effects of EMW, undoubtedly, deserve more attention. Extensive investigations are needed to understand how cell phones affect human reproductive functions.

According to Saki *et al.* (2009) forced swimming stress in the rat will reduce the number and motility of spermatozoa as well as the fertilisation capacity. Ebbesen *et al.* (2009) showed that stress may reduce the chances of a successful outcome following IVF, possibly through psychobiological mechanisms affecting medical end-points such as oocyte retrieval outcome.

We speculate that frequent callers, compared with those who do not use cell phones, are exposed to more stress, which possibly could negatively affect semen quality and impair male fertility. Although patients with a history of smoking or alcohol consumption as well as those with systemic diseases, orchitis and varicocele in our study were excluded, no study is without limitations and this applies to our study. Due to its retrospective nature, we were not able to comment on the duration, intensity of cell phone use and severity of its detrimental effects on male fertility.

We also did not evaluate our patients regarding non-EMW exposure, the effects of cell phones on stand-by mode and the effects of distance (i.e. cell phone in trouser's pocket versus shirt's or jacket's pocket) and the position of the cell phone at night, the impact of occupation as well as the influence of the environment (rural, urban living area). These are certainly limitations of our study which will be undoubtedly managed appropriately in our ongoing and future research on the same subject.

Conclusion

We speculate that mobile phones negatively affect sperm quality in men and may impair male fertility. Men with poor sperm quality planning for pregnancy should be advised not to use cell phone extensively. Studies performed on human males are scarce, therefore further studies with a careful design are needed to determine the effect of cell phone use on male fertility.

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