Effect of Mobile Phone Exposure on Cognition of Medical Students

Authors
Abhishek Sinha¹, Rinku Garg²*, Arjit Bansal³, Navpreet Mann⁴
¹Associate Professor, Santosh Medical College, Ghaziabad
²Professor, Santosh Medical College, Ghaziabad
³First year MBBS Student, Santosh Medical College, Ghaziabad
⁴Assistant Professor, Santosh Medical College, Ghaziabad
*Corresponding Author
Rinku Garg
Email: rgrinkigarg6@gmail.com

Abstract
Background: The increasing use of mobile phones in the present scenario and its adverse effects on human health is the topic of attention.

Material and Method: 50 healthy medical students of first Professional MBBS of Santosh medical college were randomly selected for the procedure. A computerized group of 15 words were presented to the participants and they were asked to reproduce it.

Statistical Analysis: Data was analysed by SPSS version 22.0 and p <0.05 was considered as significant.

Result: Our study result shows that use of mobile phones has significant negative effect on working memory.

Discussion: We conclude that use of mobile phone leads to impairment of working memory and cognition in medical students. It is therefore recommended that duration of use of mobile phones should be done in intervals rather than continuously.

Keywords: Mobile phones, Cognition, Short term memory, Working memory, Radio frequency Electromagnetic wave radiation (RF-EMW).

Introduction
The increasing use of mobile phones in the present scenario and its adverse effects on human health is the current topic of attention(1). Children and adolescents are of special interest due to their developing nervous systems(1). It has been reported that mobile phone use for as short as five minute duration can have an effect on the cognition in humans(1). Another study has shown that there is a significant effect of mobile phone use on cognition in young adolescents(2). There are various studies which show the effect of mobile phone use with media multitasking(3), use of social networking sites(4) on spatial memory(5) and cognition(3,4). Cardis et al.(6) have shown how mobile phone electromagnetic waves (EMW) are localised in the various brain areas. ICNIRP(7) has given guidelines for limiting exposure to EMW radiation and WHO(8) has also given guidelines for exposure to mobile phone radiation. On the basis of these studies, it is apparent that mobile phones have a known effect on cognition. Our aim was to study whether a short exposure (5 minutes) to mobile phones could have
an effect on the working memory and cognition of healthy subjects.

**Material and Methods**

50 healthy medical students of first Professional MBBS of Santosh Medical College were randomly selected for the procedure. Informed consent was taken. It was a cross sectional study and ethical approval was taken from the institutional ethical committee.

A computerized group of 15 common words were presented to the participants on a 15 inch laptop screen from a reasonable viewing distance at eye level under appropriate illumination and they were asked to reproduce it on three pieces of paper marked a, b and c given beforehand for the three groups mentioned below. The words were presented very briefly (4 seconds each) in order to increase the difficulty of the task. Three measurements were taken: Group A: Before using mobile phone, Group B: Immediately after using mobile phone for 5 minutes, Group C: After 5 minutes of rest.

For each observation they were given the time of 1 minute to reproduce the words and at the end the sheets were collected and the correct written words were counted which was called as “Word Score” This was entered in to the records respectively using MS Excel.

**Statistical Analysis**

The data was analysed statistically by SPSS version 22.0 and p <0.05 was considered as highly significant. Comparison between the three groups was made by one-way ANOVA.

**Result**

The subjects were in the age range of 18 to 28 years. The mean age was 19.52 years and the standard deviation was 1.64 years for the study population as shown in Table 1 46% were males and 54% of the subjects were females as depicted in Figure 1.

Figure 2 shows the comparison of word score [the number of words remembered correctly after Group a: before using mobile phone Group b: immediately after using mobile phone for 5 minutes Group c: 5 minutes after the second measurement] in the three groups. There was a statistically significant difference between the after use group (B) with before use (A) and after rest group (C). This shows that there was a significant reduction in word count after use of mobile phone and an improvement of word count after rest.

| Age range (years) | Age (years) (Mean±SD) | Gender |
|-------------------|------------------------|--------|
|                   |                        | Males N (%) | Females N (%) |
| 18-28             | 19.52±1.64             | 23(46)     | 27(54)     |

*Fig.1 Genderwise distribution of subjects*

*Fig.2 Effect of mobile phone in medical students on cognition (word score)*

**Discussion**

Our study result shows that use of mobile phones has significant (p<0.05) negative effect on working memory. The third reading (5 minutes after the 2nd
reading) was better than 2\textsuperscript{nd} reading (after using mobile phone), but worse (p<0.05) than the 1st reading (before using mobile phone).

The effects of RF-EMW on DNA damage have been reported in various studies\(^\text{[11-17]}\). Lai and Singh reported an increase in ss and ds DNS breaks in the neurons of rat exposed for 2 hrs. to a 2450 MHz field. It was seen that EMW exposure cause DNA-protein and DNA–DNA cross links which increase apoptosis in neurons\(^\text{[11,12,15,16,17]}\).

Belyaev et al\(^\text{(14)}\) have shown that exposure of rat neuron to microwaves results in changes in gene expression but does not lead to any breaks in the DNA structure. This may further lead to alteration in the healthy physiological functioning of the nervous system by expression of pro-apoptotic genes\(^\text{(14)}\).

Further, it was seen that antioxidants blocked this effect\(^\text{(18)}\). This shows that the mechanism of action of EMW on neuronal cells is free radical mediated. Similar results were found by Paul Raj and Behari\(^\text{(19)}\) in rat neurons after 35 days of exposure. Nikolava et al\(^\text{(20)}\) also reported increase in DNA double stranded breaks in embryonic stem cells.

These studies support the observation that the decrease in cognition observed in our study may be due to the effect of EMW on neurons. The mechanism of action may be free radical mediated as demonstrated by Lai and Singh in their previous study\(^\text{(18)}\).

**Conclusion**

We conclude that use of mobile phone leads to impairment of working memory and cognition in medical students aged (18-28yrs). It is therefore recommended that duration of use of mobile phones should be done in short duration intervals rather than continuously for long periods of time.

**Acknowledgement**

We would like to acknowledge the cooperation of the students who participated in this study. The authors declare no conflict of interest.

**References**

1. F Kalafatakis, D Bekiaridis-Moschou, Eirini Gkioka, Magda Tsolaki: Mobile phone use for 5 minutes can cause significant memory impairment in humans Hell J Nuclear Medicine 2017;(20 supplementry,page no-146-154)

2. Abramson M. J., Benke G. P., Dimitriadis C., Inyang I. O., Sim M. R., Wolfe R. S., et al. (2009). Mobile telephone use is associated with changes in cognitive function in young adolescents. Bioelectromagnetics 30 678–686. 10.1002/bem.20534

3. Alzahabi R., Becker M. W. The association between media multitasking, task-switching, and dual-task performance. J. Exp. Psychol. Hum. Percept. Perform. 2013, 391485–1495. 10.1037/a0031208

4. Alloway T. P., Alloway R. G. The impact of engagement with social networking sites (SNSs) on cognitive skills. Comput. Hum. Behav. 28 1748–1754. 10.1016/j.chb.2012.04.015

5. Wiholm C, Lowden A, Kuster N, Hillert L, Arnetz BB, Akerstedt T, Moffat SD: Mobile phone exposure and spatial memory. Bioelectromagnetics 2009, 30(1):59-65

6. Cardis E, Deltour I, Mann S, Moissonnier M, Taki M, Varsier N, Wake K, Wiart J: Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. Phys Med Biol 2008, 53(11):2771-2783.

7. International Commission on Non-Ionizing Radiation Protection (ICNIRP): Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. Health Phys 1998, 74(4):494-522.

8. World Health Organization (WHO): 2006 WHO research agenda for radio frequency fields. 2006.

9. Makker K, Varghese A, Desai NR, Mouradi R, Agarwal A: Cell phones: modern man's...
nemesis? Reprod Biomed Online 2009,18(1):148-157.

10. Ofteadal G, Wilen J, Sandstrom M, Mild KH: Symptoms experienced in connection with mobile phone use. Occup Med (Lond) 2000, 50(4):237-245.

11. Lai H, Singh NP: Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. Int J Radiat Biol 1996, 69(4):513-521.

12. Garaj-Vrhovac V, Horvat D, Koren Z: The effect of microwave radiation on the cell genome. Mutat Res 1990, 243(2):87-93.

13. Sarkar S, Ali S, Behari J: Effect of low power microwave on the mouse genome: a direct DNA analysis. Mutat Res 1994, 320(12):141-147.

14. Belyaev IY, Koch CB, Terenius O, Roxstrom-Lindquist K, Malmgren LO, WHS, Salford LG, Persson BR: Exposure of rat brain to 915 MHz GSM microwaves induces changes in gene expression but not double stranded DNA breaks or effects on chromatin conformation. Bioelectromagnetics 2006, 27(4):295-306.

15. Lai H, Singh NP: Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. Bioelectromagnetics 1995, 16(3):207-210.

16. Lai H, Singh NP: Acute exposure to a 60 Hz magnetic field increases DNA strand breaks in rat brain cells. Bioelectromagnetics 1997, 18(2):156-165.

17. Lai H, Singh NP: Magnetic-field-induced DNA strand breaks in brain cells of the rat. Environ Health Perspect 2004,112(6):687-694.

18. Lai H, Singh NP: Melatonin and N-tert-butyl-alpha-phenyl nitronate block 60-Hz magnetic field-induced DNA single and double strand breaks in rat brain cells. J Pineal Res 1997,22(3):152-162.

19. Paulraj R, Behari J: Single strand DNA breaks in rat brain cells exposed to microwave radiation. Mutat Res 2006, 596(12):76-80.

20. Nikolova T, Czyz J, Rolletschek A, Blyszczuk P, Fuchs J, Jovtchev G, Schuderer J, Kuster N, Wobus AM: Electromagnetic fields affect transcript levels of apoptosis-related genes in embryonic stem cell-derived neural progenitor cells. FASEB J 2005,19(12):1686-1688.