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Original Article

Effect of mobile usage on serum melatonin levels among medical students

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Abstract

Exposure to extremely low frequency (ELF) electromagnetic radiations from mobile phones may affect the circadian rhythm of melatonin in mobile users. The study was designed with objective to evaluate the influence of mobile phone on circadian rhythm of melatonin and to find the association if any between the hours of mobile usage with serum melatonin levels. All the volunteers medical students using mobiles for > 2 hrs/day were included in high users group and volunteers who used mobile for ≤ 2 hrs where included in low users group. Both high and low users volunteers were sampled three times in the same day (Morning-3-4 am, Noon 1-2 pm, Evening-5-6 pm) for estimation of serum melatonin levels. Comparsion of sernum melatonin levels in high users and low users were done by Mann Whitney "U" Test. Reduced morning melatonin levels (3-4 am) was observed in high users (> 2 hrs/day) i.e high users had a disturbed melatonin circadian rhythm.There was a negative correlation between melatonin secretion and hours of mobile usages.

Introduction

In today's modern world we are surrounded by the sea of electromagnetic fields (EMF) produced by technologies that are part of modern life. During recent years there has been increasing public concern on potential health risk from chronic exposure to low frequency electromagnetic field (EMF) emission from mobile phones. The effects of chronic exposure to electromagnetic radiations have been the subject of intensive research (1). Research show that some biological effects of EMF exposure may be mediated by hormone melatonin.

Melatonin is primarily produced by pineal gland and its synthesis is directly inhibited by ambient light exposure, resulting in diurnal secretory pattern. Melatonin secretion is important in regulation of circadian rhythms and sleep (2). Melatonin exerts physiologic effects that are enhancement of immune response, scavenging of free radicals and suppression of tumour growth in humans and experimental animals (3). A decrease in nocturnal melatonin secretion in rodents chronically exposed to EMF has been reported (4). Experiments on humans acutely exposed to EMF for a night have not resulted in reproducible effects on serum melatonin or urinary excretion of its main metabolite, 6-sulfatoxymelatonin (6-OHMS)

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(1, 5). However, recent epidemiologic studies have suggested an effect of chronic EMF exposure on levels of 6-OHMS (6, 7). In most of the studies done in past few years the authors have mostly studied the effect of EMFs on urinary excretion of melatonin metabolite (6-OHMS). Hardly a few studies have been done to see the effect of EMFs on circadian rhythm of melatonin.

The authors have already found poor sleep quality among students with increasing hours of usage of mobile per day (8). In continuation to the above findings the present study was planned to evaluate the influence of mobile phone on circadian rhythm of melatonin and to find the association if any between the hours of mobile usage with serum melatonin levels.

Materials and Methods

This descriptive analytical study was conducted at department of Physiology Swami Rama Himalayan University Dehradun. The study was approved by Institutional Ethical Committee. An informed written consent was taken from all the volunteers of medical students prior to the start of study.

Study protocol

All the volunteers students recruited were of age group 18-22 years and were subjected to investigator developed questionnaire on usage of mobile which comprised of 17 questions covering several aspect of mobile usage like- duration of mobile usage, time of day of maximum usage, keeping below the pillow. The volunteers fulfilling the inclusion criteria of more than one year of GSM mobile usage were included in the study (n=100). The volunteers were then divided into two groups (based on mobile usage of more than 2 hours). From each of the two groups 30 volunteers where randomly selected for assessment of melatonin levels and where allocated identification numbers

a) High users (n=30) – volunteers who used mobiles for > 2 hrs/day.
b) Low users (n=30) – volunteers who used mobile for ≤ 2 hrs/day Low users served as controls.

Both high users and low users volunteers were sampled 3 times in the same day [Morning (MM) 3-4 am, noon (MN) 1-2 pm, evening (ME) 5-6 pm] for estimation of serum melatonin levels.

Blood collection

Three days prior to the collection of blood the volunteers were instructed to stay under dim light conditions in the hostels with curtains kept closed, and avoid watching of television and uses of computers. Blood samples were collected by trained technicians under all antiseptic precautions. Blood samples were collected in 3.5 ml of vacutainers. The samples were labelled with participant random identification number and were stored in box at 2-8 °C temperature. Melatonin levels were quantified by ELISA Kit (Usen Life Science Inc) according to the guidelines given by manufactures cat log.

Statistical analysis

Data was analyzed by SPSS ver17. Descriptive analysis of the demographic data (gender, day of maximum usage of mobile, keeping mobile under pillow) was represented as frequency & percentages. As the data of melatonin was not normally distributed hence it was presented as median (IQR- Inter quartile range). Comparison between the groups was done using Mann Whitney "U" test of significance. Significance for the difference was set at $P<0.05$. Within the group comparison levels of melatonin was done by using repeated measure ANOVA.

Results

Volunteer students of first year were recruited from age of 18-22 years. They were divided into two groups based on the criteria laid down by the investigators (High users: mobile usage > 2 hrs/day; Low users: mobile usage ≤ 2 hrs/day). Mean age of the volunteers for the study was similar in both the groups .62.5% of the females were using mobiles for > 2 hrs/day as compared to only 37.5% of males (Table I).

Larger percentage of high users (43.8%) were using mobiles at night as compared to low users(14.3%) which could be reason for delay in the onset of sleep .37.5% of the high users also kept their phones below the pillow at night (Table I).

Since the sample was small the normality of the obtained values of melatonin in serum at all the three point of recording (Morning (MM) [3-4 AM]; Noon MN[1-2PM]; Evening ME[5-6PM]) was not achieved, therefore median and IQR was used to present the data and describe it. Circadian rhythm of melatonin secretion was seen in both groups with the low user group having morning median serum levels of 94.9 which decreased to 47.6 in the evening. Since median serum levels of morning among high users is lower (89.4) the corresponding median of low users (Table I), it reflects poor quality of sleep in high users group.

Median of noon serum melatonin levels among high users is higher (90.7) than the corresponding median of low users (58.0) and the values are more consistently at higher range in high users which reflects the day time sleepiness was observed by authors in previous study (8).

TABLE I : Demographic profile and melatonin levels among high users and low users.

Parameters	*High users (N=30)*	*Low users (N=30)*
Age (yrs) (mean±SD)	18.4±1.7	17.7±1.3
Gender		
• Males	11(37.5%)	19(64.3%)
• Females	19(62.5%)	11(35.7%)
Melatonin (pg/ml) Median (IQR)		
• Morning (MM)	89.4(IQR-68.8)	94.9(IQR-72.88)
• Noon (MN)	90.7(IQR-81.3)	58.0(IQR-56.14)
• Evening (ME)	55.1(IQR-55.74)	47.6(IQR-48.92)
• Difference of melatonin levels (MM-ME) Values Mean±SE	16.4±6.4	35.6±7.5
Time of max usage		
• Afternoon	–	1(7.1%)
• Evening	9(56.3%)	11(78.6%)
• Night	7(43.8%)	2(14.3)
Mobile Kept under Pillow at night	6(37.5%)	3(21.4%)

Repeated ANOVA justified a significant difference within the volunteers (F=9.92; df(2); p=0.001) in low users group. In high users the significant difference within the volunteers was not observed but the melatonin values increased in morning (median of 89.4) and decreased to median of 55.1 in evening suggesting normal circadian rhythm in high users but peak secretion was delayed in noon in high users (median of 90.7).

The significant rise in the melatonin levels (MM-ME) as expected physiologically in early morning was seen in low users (35.6±7.5 pg/ml). High users showed a smaller increase in the morning melatonin levels (16.4±6.4 pg/ml). Usage of mobile more during the night time could be the reason for ineffective rise of melatonin in morning hours.

Comparing the two groups for the levels of melatonin (values in Median) by Mann Whitney "U" test shows no significant difference in morning and noon samples but the evening values where higher in high users as compared to corresponding values of low users (U= 65; P=0.05) (Table II). Correlation between hours of usage and levels of melatonin showed a negative association (r=–0.66), however the strength of association was not significant.

TABLE II : Comparison of melatonin levels in high users and low userss by Mann Whitney "U" test.

Melatonin levels	*Groups*	*Mean Rank*	*"U" value*	*P value*
Morning	Low users High users	16.79±14.38	94	0.45
Noon	Low users High users	12.93±17.75	76	0.13
Evening	Low users Highusers	12.14±18.44	65	0.05

Discussion

The circadian rhythm of melatonin production (high melatonin levels at night and low levels during day) by the mammalian pineal gland is modified by visible portion of electromagnetic spectrum i.e light and reportedly by extremely low frequency (ELF) electromagnetic fields. Both light and non visible electromagnetic field exposure at night depress the conversion of serotonin to melatonin within pineal gland (9).

In the present study the significant rise in the melatonin levels as expected physiologically in early morning (3-4 am) was seen in low users. High users of mobiles had a smaller rise and the melatonin levels was maintained at higher level throughout the day time. Higher amplitude of melatonin circadian was observed in noon and evening levels in high users as compared to low users. Reduced morning melatonin levels could be due to the use of mobiles more in the night among high users (> 2 hrs/day) In the present study effort was made to account for the factors that affect melatonin secretion like light, age, BMI, drugs, smoking, alcohol. Evidences that EMR reduces melatonin in human being commenced with Wang (1989) who found that the workers who were exposed to RF had dose response increase in serotonin levels and indicated a dose response reduction in melatonin (10). This study showed that non visible electromagnetic field exposure depresses the conversion of serotonin to melatonin. A study done by EL- Helaly revealed that electronic equipment repairers who were exposed to extremely low ELF field had a lower mean levels of serum melatonin than that of controls with a high statistically significant difference ($p<0.01$) (11). Burch et al assessed melatonin levels by radioimmunoassay of its urinary metabolites, 6-hydroxymelatonin sulphate (6-OHMS) in workers exposed to 60 Hz magnetic field and found a progressive reduced excretion of the urinary melatonin metabolite 6-OHMS concentration in response to magnetic field(12). Swiss railway workers were found to have reduced evening 6-OHMS excretion after 5 days of exposure to 16.7 Hz field (13). Similarly a decreased nocturnal 6-OHMS excretion was demonstrated in male electric utility workers exposed to 60 Hz magnetic field (14). In the present study we also observed small rise in melatonin levels in early morning (3-4 am) in high users as compared to low users. There has been hardly any study on effect of mobile phone usage on melatonin secretion but in one of the study researchers have demonstrated a reduced excretion of urinary metabolite of melatonin among person using mobile phone for more than 25 min/day (15). Sleep is regulated by the central circadian oscillator in suprachiasmatic nucleus in hypothalamus. The activity of this central oscillator is in turn controlled by hormone melatonin (16). In the present study it was observed that melatonin levels were higher in high users in noon (median 90.7) compared to low users, so the values are more consistently at higher range in high users which shows that amplitude of melatonin circadian is higher in noon and evening in volunteers using mobile for more than 2 hrs/day i.e high users have disturbed melatonin circadian rhythm.Studies have reported chronic exposure to EMF leading to symptoms such as insomnia, fatigue, headache, dizziness, lack of concentration, memory problem (17). Mohamed EL reported that sleep insufficiency was more frequent among electronic equipment repairer (18%) in comparison with controls (8.5%) (11). Authors in their previous study have already reported that volunteers using mobiles for more than 2 hrs/day showed disturbed sleep (8).

Early research concerning the relationship between melatonin and sleep in animal experiments provide evidences for sleep inducing effects of melatonin, suggesting the role of this hormone in inducing sleep in humans as well (18).

Limitations

The limitations of our study were - (a) small sample size (b) EMF could not be calculated.

Conclusion

There is substantial evidence that establishes a causal relationship between hours of mobile usage and reduced melatonin secretion. There is a negative correlation between melatonin secretion and hours of mobile usage. The disturbed circadian rhythm of melatonin may be probable mechanism for serious health effects. However further studies on relationship of strength of EMF on melatonin secretion need to be done to strengthen the relationship.

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