Original Article

Application of Gas Discharge Visualization Technique for Assessing Effects of Mobile Phone-induced Electromagnetic Field on Subtle Energy Levels of Teenagers and Protective Value of Yoga Intervention

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ABSTRACT

Background: We found quantifiable effects of mobile phone-induced radio-frequency electromagnetic field (RF-EMF) on subtle energy levels of teenagers through gas discharge visualization technique in a previous randomized controlled study. The present study assesses potential protective value of simple and well-known Yoga technique of *Nadishuddhi pranayama* on RF-EMF-induced changes on subtle energy levels of teenagers. **Materials and Methods:** We enrolled thirty healthy right-handed healthy teenagers (15 males and 15 females) in the age range of 16.30 ± 2.26 years from educational institutes in Bengaluru. Each participant was assigned to four randomly allocated conditions on separate days: (1) (mobile phone in "ON" mode at right ear [MPON]), (2) (mobile phone in "OFF" mode [MPOF]), (3) (MPON mode with *Nadishuddhi Pranayama*), and (4) (MPOF mode with *Nadishuddhi Pranayama*). Subtle energy levels of various organs of the participants were measured using gas discharge visualization camera Pro device, in single-blind condition, at two points of time: (1) baseline and (2) after 15 min of MPON/MPOF/MPON with *Nadishuddhi*/MPOF with *Nadishuddhi* exposure, respectively. Repeated measures ANOVA with Bonferroni adjustment was applied to perform the data analysis using SPSS version 10.0. **Results:** After MPON condition, the following subtle energy variables showed reduction in energy levels as compared to MPOF: (1) integral area, (2) cerebral zone cortex, (3) liver, 4) spleen, (5) right kidney, (6) pancreas, (7) thyroid, and (6) jejunum. Adding simultaneous practice of *Nadishuddhi* to MPON condition did not enhance subtle energy in any of the organs. **Conclusion:** The subtle energy-reducing effects of MPON condition on various organs, as compared to sham, were consistent with our previous study. Simultaneous practice of *Nadishuddhi pranayama* for 15 min, during RF-EMF exposure, did not resist reduction of subtle energy levels. Other yoga-based techniques such as meditations may be explored in future studies.

Keywords: *Electromagnetic field, electrophotonic imaging, gas discharge visualizer, mobile phone, Nadishuddhi pranayama*

Introduction

Mobile phones are currently the most prevalent means of communication.[1] Globally, the use of mobile phones has increased many folds in all age groups. Mobile phones are among the strongest source of human exposure to radio-frequency electromagnetic field (RF-EMF).[2-4] RF-EMF exposure, especially on long term, may exert physiological effects which may be detrimental to human health.[5-8]

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Teenagers are among the most prolific users of mobile phones with around 75% owning their own cell phones.[9,10] As teenagers have smaller head circumference and have higher water content and ion concentration in their brains, RF-EMF may penetrate deeper into their brain areas making them more susceptible for potential RF-EMF-induced effects.[11]

Electrophotonic imaging (gas discharge visualization [GDV]) or GDV is based on the well-known Kirlian effect. The measurement of electrophotonic imaging (GDV) is based on the electrical activity of the human organism. The biophysical principles in the investigation of GDV technique are based on the ideas of quantum biophysics; details of GDV technique are described elsewhere.[12-15] Two studies have previously assessed the effect of mobile phone-induced electromagnetic (EM) field on subtle energy levels.[16,17] Both the studies have found quantifiable effects of RF-EMF on subtle energy parameters.

The ancient Indian science of Yoga makes the use of voluntary regulation of the breathing to make respiration rhythmic and to calm the mind. This practice is called *Pranayama*. *Nadishuddhi pranayama* means "purification of subtle energy paths;" inhalation and exhalation are through alternate nostrils for successive respiratory cycles.[18] The purpose of the *Nadishuddhi pranayama* or alternate nostril breathing is to balance the two forces of mental energy and physical energy and to bring harmony between body and mind. *Nadishuddhi pranayama* is the most commonly practiced and easy to perform pranayama. Its importance lies in its ability to clear obstructions in the flow of "prana" or subtle energy in the energy channels called "nadis."[19] This is the reason, this particular technique was selected in the present study to enhance subtle energy levels of teenagers, while they are being exposed to RF-EMF.

In a recent randomized controlled trial on 61 teenagers, we found that subtle energy levels reduced significantly in various organs after 15 min of exposure to RF-EMF as compared to sham.[17] However, no previous study has used yogic intervention to resist such RF-EMF induced changes on subtle energy levels. Therefore, the current study was planned to assess whether the simultaneous practice of *Nadishuddhi pranayama* during RF-EMF exposure of 15 min exerts any resistance to subtle energy-lowering effects of RF-EMF exposure.

Materials and Methods

Participants

We enrolled thirty healthy right-handed healthy teenagers (15 males and 15 females) in the age range of 16.30 ± 2.26 years from various educational institutes in Bengaluru city. All participants were healthy as assessed by general health questionnaire (GHQ-12), their mean GHQ score was 0.8 ± 0.55, and average body mass index was 20.5 ± 3.7 kg/m^2. Last academic performance of the participants was with an aggregate of 60.11 ± 9.6% (above average), suggesting the absence of any mental handicap. Both male and female participants who owned a smartphone and those who were able to read and write in English language were included in the study. Participants who had a history of injury to the fingers or any surgery in the past 6 months, those with congenital diseases or deformities, and those who were on any kind of regular medications were excluded from the study. Those performing regular *pranayama* since more than a month and those using mobile phones for <5 min or more than 2 h/day (for calling purpose) on an average were also excluded from the study. Table 1 provides the demographic details of the participants who participated in the current study.

Study design

Single group randomized crossover design with single-blind condition was followed [Figure 1]. Signed informed consent was taken from the participants who were above 18 years of age and from the guardian/parents of those below 18 years of age. Research was approved by the Institutional Ethical Committee. Participants were given an orientation of 15 days to perform *Nadishuddhi pranayama*. Those

Table 1: Demographic details of the participants

Variables/ condition	MPON/MPOF/MPONNS/MPOFNS (mean±SD)
n	30
Age (years)	16.30±2.26
Gender (*n*)	
Male	15
Female	15
Number of assessments	8 (before and after 4 conditions: (1) MPON; (2) MPOF; (3) MPONNS and (4) MPOFNS)
Height (m)	1.51±0.21
Weight (kg)	51.60±3.21
BMI (kg/m^2)	20.50±3.70
Head circumference	50.97±1.31
Last academic performance (%)	60.11±9.6
GHQ-12 scores	0.8±0.55

MPON: Mobile phone "ON" mode, MPOF: Mobile phone "OFF" mode, MPONNS: Mobile phone "ON" mode with simultaneous practice of *Nadishuddhi*, MPOFNS: Mobile phone "OFF" mode with simultaneous practice of *Nadishuddhi*, BMI: Body mass index, GHQ: General health questionnaire, *n*: Sample size, SD: Standard deviation

Figure 1: Design of the study - single group single-blind randomized crossover design

Pre Assessments	Intervention (*n*=30; male=15; female=15)	Post Assessments
EPI imaging (*n*=30)	MPON for 15 min MPOF for 15 min MPONNS for 15 min MPOFNS for 15 min	EPI imaging (*n*=30)

MPON: Mobile phone "ON" mode, MPOF: Mobile phone "OFF" mode, MPONNS: Mobile phone "ON" mode with simultaneous practice of *Nadishuddhi*, MPOFNS: Mobile phone "OFF" mode with simultaneous practice of *Nadishuddhi*, EPI: Electrophotonic imaging, *n*: Sample size

who were able to perform the practice correctly at the end of orientation were included in the study. Each participant was assigned to four randomly selected conditions on separate days: (1) (mobile phone in "ON" mode at right ear [MPON]), (2) (mobile phone in "OFF" mode at right ear [MPOF]), (3) (MPON mode at right ear with *Nadishuddhi Pranayama* [MPONNS]), and (4) (MPOF mode at right ear with *Nadishuddhi Pranayama* [MPOFNS]). Subtle energy levels of various organs of the participants were measured using GDV camera Pro device, in single-blind condition, at two points of time: (1) baseline and (2) after 15 min of MPON/MPOF/MPON with *Nadishuddhi*/MPOF with *Nadishuddhi* exposure, respectively.

Radio-frequency electromagnetic field exposure settings

The source of RF-EMF was a 2100 MHz 3G mobile phone with the Universal Mobile Telecommunications System's network without periodic pulsed modulation content. It was an FCC-approved device and had head specific absorption ratio (SAR) of 0.4 w/kg and body SAR of 0.54 w/kg. Participants sat on a comfortable chair with head resting on the chair, and two identical mobile phones were kept at ~0.5 cm distance from the tragus, one on each side, using an adjustable wooden stand. Left side mobile was kept in off mode permanently with battery removed. Only the right side mobile phone status was changed depending on the condition to which the participant was exposed to. Identical phones were kept on both the sides at the same distance from the ear to rule out lateralization effects. When participants were needed to be exposed to RF-EMF, i.e., in MPON groups, fully charged mobile was placed on the right side and a call was made for 15 min from another phone. Both the phones (caller and receiver) were kept mute throughout. During sham (MPOF) exposure, right side mobile was kept off with battery removed. Participants sat in a dark room and their finger impressions were taken on GDV Pro device.

Gas discharge visualization parameters

Comprehensive assessments of gas discharge visualization (GDV) energy levels at all organs were performed before and after RF-EMF and sham exposure, respectively. Integral area (IA) was considered as the primary variable as it represents overall subtle energy levels of the participant. Only status of right side mobile was changed, and hence, only right-sided GDV variables were assessed.

Gas discharge visualization procedure

Electrophotonic imaging produced by "Kirlionics Technologies International," Saint Petersburg, Russia [GDV camera Pro with analog video camera, model number: FTDI.13.6001.110310] was used to collect data. The measurements were carried out two times for each participant. The readings from all ten fingers were taken. To maintain the reliability and reproducibility of data, the given guidelines for GDV measurements were followed.[20] The measurements were made 3 h after food intake. The participants were asked to remove all metallic objects from their body which were not used by them for 24 h before data collection. They were also asked to minimize and if possible completely avoid cell phone use for previous 24 h. Participants stood on an electrically isolated surface during the measurements. Proper instructions were given to them to place the tip of the finger on the dielectric glass. Calibration of the instrument was carried out before starting measurement. To clean the surface of glass, alcoholic solution was used between each participant. Hygrometer (Equinox, EQ 310CTH) was used during data collection to record variability in atmospheric temperature and humidity. During data recording at different time intervals, mean temperature was 26.633.47 and humidity 52.18% measured in degree Celsius and percent, respectively, to check for atmospheric effects and possible variability of electrophotonic emission from human subjects.[21,22]

Nadishuddhi Pranayama

Participants were made to sit with their back, neck, and head straight. They closed the right nostril, inhaled through left nostril, exhaled through right nostril, and inhaled through right nostril, exhaled through left nostril. This is one round of *Nadishuddhi pranayama*. During orientation classes, participants were trained to perform 9 rounds in 5 min and totally of 27 rounds in 15 min, maintaining the ratio of inhalation:exhalation to 1:2. They were instructed to breathe in and out as gently as possible without holding the breath and to feel the touch of the air in the nostrils as they breathe in and breathe out, respectively.[18,19]

Data extraction and analysis

Raw data from each GDV diagram software were extracted onto an excel sheet for the analysis. SPSS version 10.0 (IBM PVT. LTD.) was used to process data for statistical analysis. Repeated measures (RM) ANOVA with Bonferroni adjustment was applied to perform the data analysis. Separate RM-ANOVA was applied for each of the 42 variables with four conditions (MPON, MPOF, MPONNS, and MPOFNS) as between-group variables and two levels (pre and post) as within-group variables.

Results

Within-group comparison revealed that IA reduced significantly after MPON exposure [Table 2]. Comparison between the conditions revealed that after MPON condition, the following subtle energy variables showed reduction in energy levels as compared to MPOF: (1) IA ($P < 0.05$), (2) cerebral zone cortex ($P < 0.01$), (3) liver ($P < 0.05$), (4) spleen ($P < 0.05$), (5) right kidney ($P < 0.05$), (6) pancreas ($P < 0.05$), (7) thyroid ($P < 0.05$), and (6) jejunum ($P < 0.05$). Adding simultaneous practice of *Nadishuddhi* to MPON condition did not enhance subtle energy in any of the organs. Adding simultaneous practice of *Nadishuddhi* to MPOF condition leads to significant reduction in IA after the practice of *Nadishuddhi* [MPOF vs. MPOFNS; Table 3]. Figure 2 provides the details of changes in IA before and after all the four conditions studied in the current study.

Discussion

The present randomized crossover study was planned to assess protective value of *Nadishuddhi pranayama* against subtle energy lowering effects of RF-EMF. Overall, we found that the subtle energy fields have tendency to reduce more when the participants are exposed to RF-EMF than in controls in various organs. These results are consistent with our previous randomized controlled study where we found similar effects of RF-EMF on subtle energy levels. Adding *Nadishuddhi* did not produce any significant subtle energy-enhancing effects irrespective of ON or OFF status of mobile phones. On the other hand, we found that adding *Nadishuddhi* procedure without RF-EMF exposure had an independent subtle energy-reducing effect on IA as compared to MPOF condition [Table 3].

Above findings suggest that RF-EMF produces a demonstrable change in the subtle energy levels of an individual as measured through GDV technique. IA is a marker of overall energy field, and our results show that RF-EMF exposure reduced the overall energy field as compared to control [Table 2 and Figure 2] in as small a duration of exposure as 15 min. Along with IA, we found that there was a definite subtle energy deficit in the area of cerebral cortex as well. Our participants held their mobile phones in the usual position of use on the right side. Here, we have found that overall cerebral zone cortex had reduced energy suggestive of diffuse subtle energy-lowering effects of RF-EMF rather than localized effects. Considering recent evidence of increased association between long-term exposure to high dosage of RF-EMF exposure and brain tumors.[23,24]

These findings are highly important. This could in future turn out to be an important screening tool for high-risk populations and help diagnose such abnormalities much earlier. Up to now, little research has explored possible influences of long-term RF-EMF exposure on such

Table 2: Comparisons of electrophotonic imaging values of integral area before and after various exposure conditions

Variable	*n*	Condition	Mean±SD		*F*	df (hypothesis, error)	*P*[a]
			Pre	Post			
IA	30	MPON	−0.048±0.24	−0.110±0.32	2.310	3, 42	0.04*
	30	MPOF	−0.0086±0.30	0.088±0.18			0.28
	30	MPONNS	−0.013±0.34	−0.129±0.36			0.31
	30	MPOFNS	0.036±0.30	−0.026±0.31			0.25

[a]Repeated measures-ANOVA with Bonferroni adjustment, *P<0.05. MPON: Mobile phone "ON" mode, MPOF: Mobile phone "OFF" mode, MPONNS: Mobile phone "ON" mode with simultaneous practice of *Nadishuddhi*, MPOFNS: Mobile phone "OFF" mode with simultaneous practice of *Nadishuddhi*, IA: Integral area, SD: Standard deviation

Table 3: Comparisons of electrophotonic imaging values of integral area between various exposure conditions after the exposure

Variable (conditions)	*n*	Mean±SD				*P*[a]			
		Post-MPON	Post-MPOF	Post-MPONNS	Post-MPOFNS	1 versus 2	1 versus 3	2 versus 4	3 versus 4
IA	30	−0.110±0.32	0.088±0.18	−0.129±0.36	−0.026±0.31	0.012*	0.80	0.041*	0.22

[a]Repeated measures-ANOVA with Bonferroni adjustment, *P<0.05. MPON: Mobile phone "ON" mode, MPOF: Mobile phone "OFF" mode, MPONNS: Mobile phone "ON" mode with simultaneous practice of *Nadishuddhi*, MPOFNS: Mobile phone "OFF" mode with simultaneous practice of *Nadishuddhi*, IA: Integral area, SD: Standard deviation

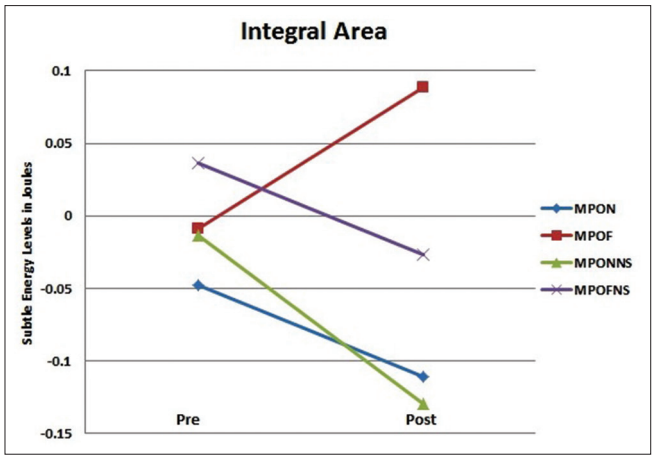

Figure 2: Figure showing changes in integral area before and after the exposure to four conditions. MPON: Mobile phone "ON" mode, MPOF: mobile phone "OFF" mode, MPONNS: Mobile phone "ON" mode with simultaneous practice of Nadishuddhi, MPOFNS: Mobile phone "OFF" mode with simultaneous practice of Nadishuddhi, IA: Integral area

organs, but in future, both animal and human studies should be performed to investigate its effects.

Our null hypothesis that *Nadishuddhi pranayama* would not have a protective effect against RF-EMF-induced changes could not be rejected in this study. We did not find any protective effect of *Nadishuddhi pranayama* in any of the subtle energy areas measured. On the contrary, *Nadishuddhi* itself without MPEMF exposure leads to reduced energy levels in IA [Table 3]. One explanation for this may be that the participants might have developed discomfort or fatigue by performing *Nadishuddhi* for 15 min continuously (as this practice requires considerable exertion with hands), which would have had subtle energy-lowering effects. Future studies should explore other possible yoga interventions, which may be effective in resisting RF-EMF-induced subtle energy-lowering effects. Future studies should be performed on larger sample size to provide high translational value.

To the best of our knowledge, this is only the third study to use GDV for assessing the effect of RF-EMF on the subtle physiology. It is the first to investigate the possible use of *pranayama* for protection against decreased subtle energies due to MPEMF. The first study was performed by Kononenko *et al*. (2000).[16] They were similar to our study in their measurement of mobile phone effects in both On and Off modes, and in attempting to assess means of protection, but they differed in timings adopted, and protective means investigated. Whereas the current study reported here used a 15 min time interval, a study by Kononenko *et al*. used 5 min time intervals. As regards means of protection, Kononenko *et al*. investigated mechanical devices, whereas we used *Nadishuddhi pranayama*. Kononenko *et al*. did not study all parameters, whereas we measured all possibilities.

It is difficult to understand the possible mechanism through which RF-EMF might affect subtle energy levels of the participants. We monitor subtle energy of chi (or prana) moving in the body through GDV system. The body is basically an electrical network of the nervous system, and long and short distance cellular communications are also hypothesized through EM signals in the body.[21] Thus, it is highly likely that any EM input from outside the body will affect the electrical communication within the body.

Strengths of the study

We used a robust, randomized, crossover design. It is a multidisciplinary study involving engineering, yogic, and subtle energy sciences to address public health issues involved in mobile phone use.

Limitations of the study

First, we did not measure any corresponding biochemical test such as blood sugar levels, thyroid-stimulating hormone, adrenaline, cortisol, liver function tests, or kidney function tests to strengthen the correlation between GDV findings and standard biochemical parameters as well as the effect of RF-EMF on these biochemical markers. Second, we did not measure electrical activity of organs such as heart or brain using electrocardiogram or electroencephalogram along with GDV imaging for better correlations. Since the changes at subtle energy level seem to occur much earlier than those produced at biochemical level, it is difficult to say that a definite correlation would be found between GDV parameters and biochemical markers at the present state. Still, future researches should explore this area.

Future studies

A larger randomized control trial with more participants should further explore the implications of the results reported here. It should compare the effects of RF-EMF on different age groups: children, teenagers, and adults. Other yoga interventions such as meditations may be explored to resist RF-EMF-induced changes on subtle energy levels.

Conclusion

The subtle energy-reducing effects of RF-EMF on various organs, as compared to sham, were consistent with our previous study. Simultaneous practice of *Nadishuddhi pranayama* for 15 min, during RF-EMF exposure, did not resist reduction of subtle energy levels. Other yoga-based techniques such as meditations may be explored in future studies.

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Conflicts of interest

There are no conflicts of interest.

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