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Research paper

Changes in electrophotonic imaging parameters associated with long term meditators and naive meditators in older adults practicing meditation



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ABSTRACT

Introduction: Anapanasati meditation is one of the techniques, practiced in the initial part of Vipassana in Theravada School of Buddhism. In this method, practitioners focus their entire attention on the incoming and outgoing breath. Study aims to observe effect of Anapanasati meditation and gender related differences on the electrophotonic imaging (EPI) parameters at physiological and psychophysiological level in long-term meditators and naive meditators.

Methods: The study consisted of 309 subjects: 199 long-term and 110 naive meditators. Subjects were divided into two groups, long-term meditators (LTM) practicing for 12 months or longer (mean months of practice 79.22 ± 49.10 , daily 1.68 ± 1.02 h) and naive meditators (NM) practicing for the first time, for seven days daily for 2.30 h. A total 266 subjects were included in the analysis after excluding 43 outliers. Comparisons were between long-term meditators and naive meditators on EPI parameters: Activation Coefficient (AC, stress parameter), Integral Area (IA, general health parameter) and Integral Entropy (IE, disorderliness parameter).

Result: Comparison between groups yielded less disorderliness (IE) at the psychophysiological level in NM group. The gender related results showed highly significant improvements in the health related parameter (IA) at the physiological and psychophysiological level in LTM and NM females compared to males.

Conclusion: The findings showed larger health related (IA) advantages in LTM and NM group at the physiological and psychophysiological level. Stress (AC) was LTM and NM females compared to males. Moreover, naive meditators also exhibited positive trends on parameters of EPI after seven days practice of meditation which was similar to LTM.

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1. Introduction

Meditation originally developed as a spiritual practice in India, having close associations with Yoga Philosophy. Later these practices spread widely and underwent transformations in different places and gave rise to a new tradition within Buddhist spiritual lore such as Zen [1]. In the tradition of spirituality, meditation has been practiced as a tool to develop spirituality, gain inner peace, improve concentration and enhance positive emotions like love and kindness. It has been used to reduce negative emotions such as fear, anger and hatred [2]. Western scientists involved in meditation research, define it as group of self-regulatory processes focussed to maintain one's attention and awareness [3]. Meditation is defined as a mental conscious process

that induces integrated psychophysiological changes, is also termed as relaxation responses [4].

There are different techniques of meditation used to study the changes at the body and mind level. In all the techniques of meditation, regulation of attention plays important role [5]. Meditation has been widely accepted as a potential method of overcoming stress and enhancing over all well-being [1]. The techniques of meditation can be practiced by people of any religion, age, educational background and culture, irrespective of any belief or life style. Older people may also practice meditation who may have less mobility, finances or will power to adjust their routine [6].

One of the most popular meditation techniques used in research is mindfulness meditation. It has its origin in Buddhist meditation of mindfulness and insight, known in Pali literature as "satipatthana-vipassana" [2]. Anapanasati meditation is one of the techniques, practiced in the initial part of Vipassana in Theravada

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School of Buddhism. In this meditation practitioners focus their entire attention on the incoming and outgoing breath. The result of such attention induces clarity, calmness and stability of mind [7,8].

Now attention is focused on assessing effect of meditation on those who practice regularly over a long period of time [9]. Meditation has been traditionally conceived to be a part of life long practice, the benefits of which were not expected to be profound in a short-term practice. A report studied EEG patterns in long-term meditators and naive meditators (seven days) with loving-kindness-compassion (Tibetan Buddhist Tradition) as an intervention. This study found that meditation impacts emotion processing irrespective of if the technique focuses on cognition or emotion [10].

Studies have shown that even 5–7 days of meditation practices can provide benefit, improving attention and eliciting changes in brain activity [11,12]. There are findings in which 5 days of 20 min per day meditation practice has shown improvement in attention, lower anxiety, depression anger and fatigue and a significant decrease in stress [12]. Electrophysiological studies with meditation intervention has shown increased theta activity which is related to heightened attention, decreased activity and less thought content [14–16].

Several studies have reported and identified the risk factors related to elderly people [17–20]. Research findings suggest that alternative and complementary therapies including meditation play a very important role in coping and reducing concerns related to well-being in older people [2,6,7,9,20–22].

In the earlier studies however, there were differences in age, intervention and duration of practice and the methods of measurements used to understand the effects on older adults.

The current study sought to address some of these problems and further study gender related issues in energy pattern, stress, psychophysiological status and well-being, in age-matched older long-term meditators and naive meditators using Electrophotonic Imaging. First, the study expected that those older adults who regularly practice meditation for long periods of time would benefit more than naive meditators. Second, it was expected that even naive meditators with one week of practice would have positive trends similar to long-term meditators in the electrophotonic imaging parameters. In addition, the study expected that females would experience more positive effect due to meditation practice in comparison to males in overall energy pattern observation.

Moreover, our intent was to discover both in the area of meditation and EPI Assessment. We limited our discovery process in this trial to one particular form of meditation not because of a bias to that form of meditation, but as a starting place to explore and better understand all meditation techniques. In addition, given electrophotonic imaging analysis is an emergent methodology, it is intended that this trial would contribute to the growing base of references on the methodology.

2. Application of electrophotonic imaging (EPI)

Electrophotonic imaging (EPI), also termed as gas discharge visualization, works on the Kirlian effect. It is used in the measurement of electron availability due to an impressed electromagnetic field. It provides both physiological and psychophysiological information of the test subject [23]. EPI works through the impression of high electric field which draws electrons from the body. Unlike the homeostatic state which is fairly stable, the characteristics of electron emission vary in humans dependent on different internal and external conditions [24]. In EPI measurement, low electrical current which is in microamperes with high voltage (10 KV) and high frequency (1024 Hz) is applied to the fingertips for less than a millisecond as a stimulant to draw

electron from the body [25]. In response to the given stimulation, there is a formation of glow around the finger, which is captured by an optical CCD camera [26]. The image taken by camera is known as GDV gram. In this process due to the effect of electromagnetic field, electrons and photons are drawn from the cutaneous layer of skin [27]. The images of EPI can be quantified and reproduced in diverse areas of scientific research. There are ten images taken from fingers of both hands' which reflect the individual's health. If an image is not symmetrical, it shows an energy imbalance in a related area of the human body [28]. There are changes in images according to the person's current psycho-emotional state. Every image with health information is analyzed by the inbuilt software of EPI. The interpretation is derived based on acupuncture meridian theory [29]. To know the physiological and psychophysiological functioning of human system, two measurements are carried out, namely with filter and without filter [26]. The filter is a specially designed plastic sheet which changes the propagation of electron avalanches along the surface existing on the tip of the finger; thus, a measurement with filter is related to status at physiological level while one without the filter is related to psychophysiology.

Bioelectrographic application of EPI has been used in a different area of research and diagnosis. It is also used to study liquids and different materials. EPI readings for metallic object have variability around 8–10% [28] whereas in healthy subject the variability is 4.1–6.6%. [26] EPI is noninvasive, safe and gives quick assessments and analysis about a physiological and psychophysiological state of humans [26].

3. Methods

The study consisted of 309 subjects: 199 long-term and 110 naive meditation practitioners. Subjects were recruited from two meditation centers: The Pyramid Spiritual Trust, Kailasपुरi, Hyderabad and Pyramid Valley International, Bangalore, India. Subjects were divided into two groups, long-term meditators (LTM) practicing from 12 months or longer (mean months of practice 79.22 ± 49.10 , daily 1.68 ± 1.02 h) and naive meditators (NM) practicing daily 2.30 h (5.00–7.30 AM) for seven days. A total of 266 subjects were part of the analysis after excluding 43 outliers (25 from LTM and 18 from NM respectively). 105 males (mean age 56.10 ± 7.26 years) and 69 females (mean age 54.38 ± 5.91 years) in LTM and 53 males (mean age 54.21 ± 6.94 years) and 39 females (mean age 54 ± 5.97 years) in NM group, constituted the study population. The subjects having health issues or extreme values, with only one measurement (either with or without filter measurement only) and defective images, were considered outliers [30]. Signed informed consent was obtained from subjects for voluntary participation in the study. Ethical approval was obtained from the Institutional Ethical Committee to carry out the study. The research design was cross-sectional and data were collected using electrophotonic imaging (EPI).

The included subjects were; healthy volunteers, age range from 45 to 70 years, both genders and willing to participate in the study and included either in LTM or NM group, subjects were required to have either at least 12 months of prior meditation practice experience or able to participate in a seven days meditation program. Exclusion criteria were; subjects with missing or partially missing fingers, smokers or having alcohol on the test day, having any other disease or on prescription drugs.

Demographic questionnaires were administered to all subjects to obtain self-reported health status, age, meditation practice experience and for assigning to a groups. During measurement, nostril dominance was checked manually by keeping a finger close to the nose and asking subjects to breathe out with closed mouth.

3.1. Data acquisition and analysis

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. Raw data from an EPI diagram program was extracted onto an excel sheet for the analysis. R statistical packages (R version 3.0.1 2013) by R Foundation for statistical Computing Platform were used to process data for statistical analysis [31]. Independent *t*-test was performed between groups where a level of $p < 0.05$, $p < 0.01$ and $p < 0.001$ were considered as statistical significant, high significance and highly significant respectively. Hygrometer (Equinox, EQ 310CTH) was used during data collection to record variability in atmospheric temperature and humidity. During data recording at the different time intervals, mean temperature was 26.63 ± 3.47 and humidity 52.18% measured in Degree Celsius and percent respectively to check for atmospheric effects and possible variability of electrophotonic emission in human subjects [26].

3.2. EPI Parameters

(1) Activation coefficient (AC, normal values are between 2 and 4 in healthy individuals): AC is the measurement of stress level and values are obtained by comparing with and without filter readings. AC recording consists of sympathetic and parasympathetic functioning of the body system. (2) Integral area (IA, normal values are between -0.6 and $+1$ in healthy individuals): IA is an index of general health of an individual measured in EPI assessment. 3. Integral entropy (IE, normal values are between 1 and 2 in healthy individual): IE is an evaluation of disorderliness of energy in the systems of the body [32,33]. Usage of EPI is in the fields of medicine, research and energy measurements.

3.3. Procedure

The measurements were carried out two times each day during the seven days retreats of anapanasati meditation in Hyderabad and Bangalore meditation centers. Long-term meditators were asked to come for the recordings before the start of meditation while naive meditators were asked to attend only on the last day after completing 7 days of practice. The readings from all 10 fingers were taken twice: with filter and without filter. To maintain the reliability and reproducibility of data, the given guidelines for EPI measurements were followed [34]. The measurement was done three hours after food intake. The subjects were asked to remove all metallic things which were not used by them all 24 h in a day.

Subjects were asked to stand on an electrically isolated surface during the measurements. Proper instruction was given to them to place the tip of the finger on the dielectric glass. Calibration of the instrument was done before starting measurement. To clean the surface of glass, alcoholic solution was used between testing of each subject.

4. Results

4.1. Comparison of EPI parameters between LTM and NM groups

In Table 1 stress parameter (AC) showed positively lower values for LTM as compared to NM group but this difference was not significant. At the physiological level, LTM group exhibited positive lower values in IAWR and IEWR as compared to NM group.

At the psychophysiological level, NM group showed positively lower values in IANL (Health parameter). The parameters related to disorderliness of energy in the body (IENL) showed positively lower mean values in NM group as compared with LTM group. Study observed significant lower mean values of IENR ($p = 0.03$) in NM group as compared to LTM group. This result showed improvement in the energy field of naive meditators.

4.2. Gender related trends in EPI parameters within groups

Table 2 shows females in LTM and NM group have more stress (AC parameter) in comparison to males but this result was not significant. At physiological level, both group demonstrated health related improvement with lower values of IAWL parameter. The result was highly significant in LTM females ($p < 0.001$) whereas in NM females this was significant with less statistical values ($p = 0.03$) as compared to males. Results of IAWR in both group also showed highly significant (LTM $p = 0.001$, NM $p = 0.004$) health related improvement in females in comparison to males. Females of LTM and NM group showed less disorderliness physiologically as compared to males within group.

At the psychophysiological level, highly significant ($p < 0.001$) health related improvement with lower IANL mean values were found in LTM females as compared to males. This improvement was also observed significantly ($p = 0.03$) in NM females in comparison to males. Females have positive lower mean values of IANR in both groups (LTM $p < 0.0$, NM $p = 0.02$) as compared to males.

At psychophysiological level, LTM females have more disorderliness of energy (parameters IENL and IENR) than males but this difference was not significant. NM females showed positively reduced disorderliness of energy in left side (IENL) as compared to male.

Table 1
presents Between Group trends in EPI parameters.

Type of measurement	Variable	LTM mean \pm sd	NM mean \pm sd	<i>p</i> -value
Physiological (with filter)	AC	2.53 \pm 0.80	2.55 \pm 0.95	0.88
	IAWL	0.49 \pm 0.13	0.49 \pm 0.12	0.98
	IAWR	0.49 \pm 0.13	0.50 \pm 0.12	0.92
	IEWL	1.94 \pm 0.14	1.93 \pm 0.16	0.78
	IEWR	1.93 \pm 0.17	1.95 \pm 0.15	0.58
Psychophysiological (without filter)	IANL	0.22 \pm 0.16	0.19 \pm 0.22	0.25
	IANR	0.20 \pm 0.18	0.22 \pm 0.17	0.33
	IENL	1.88 \pm 0.17	1.84 \pm 0.19	0.13
	IENR	1.88 \pm 0.16	1.83 \pm 0.19	0.03*

LTM: long-term meditator, NM: naive meditator, AC: activation coefficient, IAWL: integral area with filter left, IAWR: integral area with filter right, IEWL: integral entropy with filter left, IEWR: integral entropy with filter right, IANL: integral area no filter left, IANR: integral area no filter right, IENL: integral entropy no filter left, IENR: integral entropy no filter right.

* $P < 0.05$.

Table 2
Presents within Group Gender related trends in EPI parameters

Type of Measurement	Variable	LTM		p-value	NM		p-value
		Male mean \pm sd	Female mean \pm sd		Male mean \pm sd	Female mean \pm sd	
Physiological (with filter)	AC	2.48 \pm 0.80	2.61 \pm 0.81	0.33	2.42 \pm 0.94	2.72 \pm 0.94	0.14
	IAWL	0.52 \pm 0.13	0.45 \pm 0.11	0.001***	0.52 \pm 0.12	0.46 \pm 0.11	0.03*
	IAWR	0.52 \pm 0.12	0.46 \pm 0.12	0.001	0.53 \pm 0.12	0.45 \pm 0.12	0.004**
	IEWL	1.95 \pm 0.15	1.93 \pm 0.14	0.36	1.94 \pm 0.16	1.92 \pm 0.15	0.61
	IEWR	1.94 \pm 0.15	1.93 \pm 0.19	0.79	1.95 \pm 0.16	1.94 \pm 0.14	0.58
Psychophysiological (without filter)	IANL	0.25 \pm 0.15	0.16 \pm 0.17	0.001***	0.23 \pm 0.21	0.13 \pm 0.23	0.03*
	IANR	0.23 \pm 0.17	0.15 \pm 0.19	0.01**	0.26 \pm 0.17	0.18 \pm 0.16	0.02*
	IENL	1.87 \pm 0.17	1.89 \pm 0.19	0.55	1.85 \pm 0.18	1.83 \pm 0.20	0.54
	IENR	1.88 \pm 0.16	1.89 \pm 0.15	0.76	1.83 \pm 0.19	1.83 \pm 0.20	0.97

LTM: long-term meditator, NM: naive meditator, AC: activation coefficient, IAWL: integral area with filter left, IAWR: integral area with filter right, IEWL: integral entropy with filter left, IEWR: integral entropy with filter right. IANL: integral area no filter left, IANR: integral area no filter right, IENL: integral entropy no filter left, IENR: integral entropy no filter right.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

5. Discussion

This study examined the effect of Anapanasati Meditation in older adults and compared the results between two groups: Long-Term Meditators and Naive Meditators. Stress parameter (AC) was found less in long-term meditators in comparison to naive meditators. The values of general health index (IA) at the physiological and psychophysiological level were positively lower on the right side in long-term meditators in comparison to NM. The disorderliness in energy pattern (IE) on the right side, in long-term meditators was positively lower than NM. This result was less at the physiological level not psychophysiological. IENR mean values were significantly lower in NM group as compared to LTM. Positive lower values of health parameter (IA) left side were found in NM at psychophysiological level. There was less disorderliness in the energy pattern (IE) in NM except IEWR in comparison to LTM group physiologically and psychophysiological. More importantly, the results of the study showed the lasting effect of the practice of Anapanasati Meditation in older adults. The beneficial effect of this meditation was also exhibited in naive meditators psychophysiological who were investigated after one week of practice.

A gender based analysis was also carried out at the two levels, namely; physiological and psychophysiological with age-matched healthy older adults. The overall gender related results of the study are consistent with our hypotheses. LTM females were found to have more disorderliness in energy at psychophysiological level as compared to males. In gender wise observation stress was found more in females of LTM and NM groups as compared to males.

5.1. Between groups analysis

The factors responsible for weaker functioning of the body systems are perceived stress, traumatic life events, chronic stress and daily stressors in mid-life or late life [35–37]. The stressful events in the life manifest through biochemical pathways in the form of increased cortisol levels [38] and neurotoxicity [39]. The cumulative stress is supposed to be connected with prolonged physiological arousal which impact adversely the human system [40]. Meditation is a form of relaxation therapy which not only induces relaxation responses but also produces an altered state of consciousness which gives possible beneficial effects in stress reduction [21]. Mindfulness meditation is an effective strategy for regulation of self-emotions, stress reducing and stress protective tool in older adults [38,41]. Findings of the present study are consistent with previous findings where long-term meditation

practice has shown positive effect on brain activity. Stress reduction, heightened attention, less thoughts and improvement in cognitive performances and emotional intelligence are reported due to long-term meditation practices [10,42–50]. In long and short-term meditation practitioners, stress reduction is reported possibly due to swift from activation of sympathetic nervous system to parasympathetic and other decreased physiological changes in heart rate, respiratory rate, pulse rate and blood pressure [48]. Recently a pilot study on Anapanasati meditation showed reduction in stress and health parameters of EPI [30]. At the physiological and psychophysiological level, long-term meditators showed less mean values of EPI parameters which in turn indicates improvement and availability of larger functional energy in the system [26]. In comparison lesser disorderliness was found in energy field in NM group than LTM. Earlier studies with intervention of Cyclic Meditation and Healing Treatment have reported that reduction in disorderliness is indication of harmonization of energy and reduced stress in the system of human body [51,52]. Possible reason for such results could be immediate effect after seven days practice in NM group whereas there is a wash-out of such effect in LTM.

5.2. Gender based analysis

The present study observed existence of higher stress (AC) in females as compared to males but the values were not significant. Meditation practices have been proved to be the effective tool to reduce stress and enhance overall well-being [30,51,53]. A possible reason for such trends may be that females tend to experience more stress both at home and at work. Thus, they are more likely to get stress-related health hazards such as obesity, depression, anxiety and hypertension in comparison to males [54,55]. In this context socioeconomic and cultural factors are also seen to be contributory to enhance stress in females whereas work responsibilities are causative factors for stress in males [55,56].

At the physiological and psychophysiological levels, the results showed greater improvement in health index (IA) in females than males. Lower values of health parameters were observed in both the groups: LTM and NM females but highly significant improvement was in LTM females. These results are in tune with previous findings where females have shown more beneficial effects due to different meditation practices and when given task performances [57–61]. It is documented that females get more positive changes because of their inherent orientation towards spirituality and practices like meditation [62,63]. Females will have more stress

(compared to males) that causes psychosomatic diseases, but have good general health—this is the overall conclusion of this work.

If practiced regularly meditation provides more equilibrium and healthier functioning of the body system physiologically and neurophysiologically [42]. The current study also presents the same findings where more positive changes occurred in LTM group than NM. Gender based analysis also provides results which are consistent with the hypotheses. Females of both group LTM and NM showed positively less disorderliness of the energy (IE) at the physiological level in the system. Earlier studies have shown that relaxation practices like meditation gives positive response to bring harmony in the system [53,64]. Thus in the preview of earlier and present findings it is quite obvious that long-term meditation is helpful to overcome physiological and psychophysiological health hazards in older adults. The seven days practice of Anapanasati Meditation also has shown apparently advantages and the trend is in the direction of long-term practitioners.

5.3. Strength of the study

This is perhaps the first study using EPI parameters to observe differences in long-term meditators and naive meditators in older adults. The observation of gender differences was carried out to track the effect in long-term practitioners and naive meditators. Study presents reliability and reproducibility and all efforts are undertaken to avoid confounders in the measurement while using EPI.

5.4. Limitation of the study

Limitations of the studies are absence of control group to compare with LTM and NM and self-reporting demographic information. Moreover, we limit our discovery process in this trial to one particular form of meditation not because of a bias to that form of meditation, but as a starting place to explore and better understand all meditation techniques.

5.5. Future recommendations

Our intent is to discover both in the area of meditation and EPI Assessment. In addition, given electrophotonic imaging analysis is an emergent methodology, it is intended that this trial would contribute to the growing base of reference on this methodology. The following points to be incorporated in future studies using EPI: (a) use of a control group to compare with LTM and NM; (b) objective measurement for correlation with outcome measures; (c) equal numbers of both males and females.

6. Conclusion

In summary, this study exhibited that despite several factors influencing psychophysiological health status in older adults, Anapanasati Meditation was effective and beneficial. The findings in the study suggest overall health index of long-term meditators (LTM) and naive meditators was positively improved and results were highly significant. In gender related finding, females experience with more stress in comparison to males which is causative factor in psychosomatic disease. Moreover, overall trends of results demonstrate that seven days regular practice of meditation by naive meditators induced similar trends of effect in this study as seen in LTM group.

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