

Spatio-Temporal EEG Spectral Analysis of Shambhavi Maha Mudra Practice in Isha Yoga

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Abstract: An effort was made to analyze the cerebral electrical activity of nine experienced Isha Yoga practitioners by means of EEG recordings. The EEG data was recorded before and after Shambhavi Maha Mudra practice in Isha Yoga, which is considered to be an antidote to stress. A complete spectral and statistical analysis was done on the data collected to analyze the changes in delta, theta, alpha and beta rhythms. The analysis of the mean relative band power of the data collected after the practice showed a high increase in the delta band power [$p < 0.05$ for F4 & F8] accompanied by an increase in theta band power. There was also a marked decrease in beta band power [$p < 0.05$ for O2, C3 & T3] almost throughout the entire hemisphere and a slight decrease in alpha band power in fronto-parietal and midline brain regions. Furthermore, an increase in coherence between the left and right hemisphere was observed accompanied by a high increase in slow-wave progression $[(\text{Delta} + \text{Theta}) / \text{Alpha}]$ in most of the brain regions. The results clearly show a higher level of mental and lower level of physical consciousness experienced in Shambhavi Maha Mudra Practice in Isha Yoga.

Indexing terms: EEG, Band Power, Coherence, Slow-wave Progression, Shambhavi Maha Mudra, Isha Yoga, Consciousness

1. INTRODUCTION

Since last many years, research has been conducted to analyze the effect of meditation on changes in human physiology [1-3]. The fact that different conscious states are accompanied by different neuro-physiological states and the brain electrical activities measured would reflect these changes explains the use of EEG for such studies [4]. Spatio-temporal patterns of these EEG activities could be traced to analyze the relation between meditation and their underlying neuro-physiological changes.

Numerous studies have reported changes in various brain rhythms emphasizing the positive effects of meditative state as compared to any type of non-meditative state [5-8]. Most of these studies have indicated an overall slowing down of brain rhythms after meditation. However variations in changes of rhythms were also observed between different types of meditations. Reasons stated for such variations were the different techniques used in different types of meditations and specific practices leading to specific changes [9].

The present study attempts to explore the effect of Shambhavi Maha Mudra in an Isha Yoga program. Isha Yoga, known as a powerful method for awakening and expanding consciousness, involves simple postures and meditation. In their Inner Engineering program, transmission of the Shambhavi Maha Mudra – a powerful process of immeasurable antiquity – is offered to purify the system and improve health, productivity, balance and inner well being [7]. This study analyzes and discusses the neuro-physiological changes subsequent to this practice using EEG.

2. MATERIALS AND METHODS

2.1. Subjects

Nine healthy experienced Isha Yoga practitioners, (5 F, 4 M) of age between 21 to 36 years (mean = 26.1 ± 4.34 years) participated in this research study as subjects. They were all from Isha Yoga Foundation, Coimbatore with many years of experience (10-11 years) of doing Isha Yoga. The subjects had no history of neurological or psychiatric disorders and none of them were on any medication. The experiment paradigm was explained fully and written consent was obtained from each of the participants.

2.2. EEG Recordings

The EEG data was recorded from 19 electrode positions on the scalp (FP2, F4, C4, P4, O2, F8, T4, T6, FP1, F3, C3, P3, O1, F7, T3, T5, FZ, CZ, PZ) according to the International 10-20 system of electrode placement, referenced to the linked ear lobe electrodes. Fig 1 visualizes the montage showing the electrode placement.

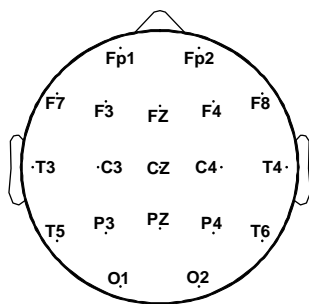


Fig 1 Electrode montage

All recordings were done in similar conditions on various days using Comet XL EEG – A Grass Telefactor System with AS40 Amplifier system and Windows® based TWin® 3.5a EEG Record

and Review Software at Sir Ganga Ram Hospital, New Delhi. The filter settings were as: LF 1 Hz, HF 70 Hz and sampling frequency fixed at 200 Hz.

2.3. Experimental Paradigm

Artifact-free epochs of 3-seconds duration were selected from the EEG recordings of each of the subjects immediately before and after Shambhavi Maha Mudra practice. These recordings were formally called BASELINE1 and BASELINE2 respectively. The entire procedure was carried out in a quiet room and took approximately 40 minutes including preparation of the subject.

2.4. Analysis

After computing the Fast Fourier Transform, the absolute band power for prominent EEG spectral bands (Delta: 1-4 Hz, Theta: 4-8 Hz, Alpha: 8-13 Hz and Beta: 13-30 Hz) was calculated. Following this, the relative band power was averaged over all the subjects and is shown in Fig 2.

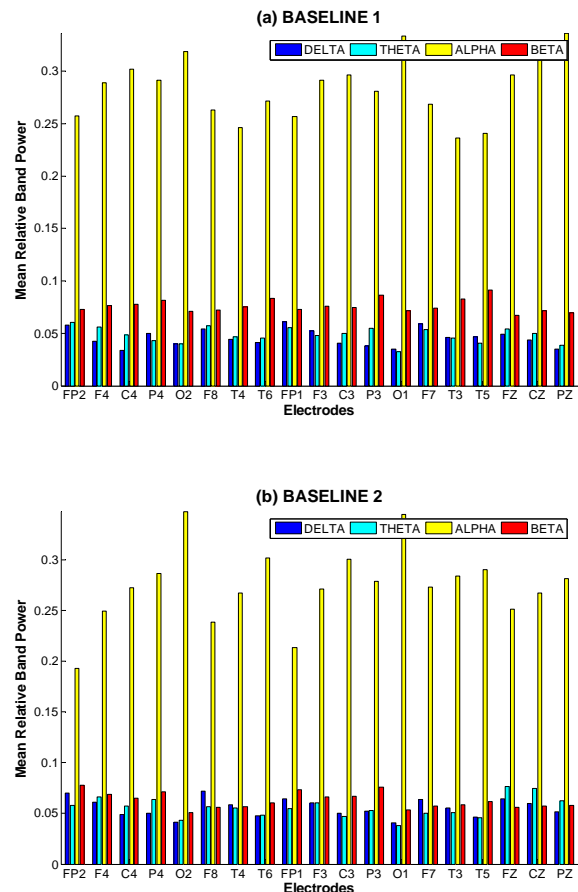


Fig 2 Mean relative band powers (a) before and (b) after the practice

Topographic head maps showing the distribution of the various brain rhythms on the scalp are shown in Fig 3, where red depicts the maximum and blue depicts the minimum appearance.

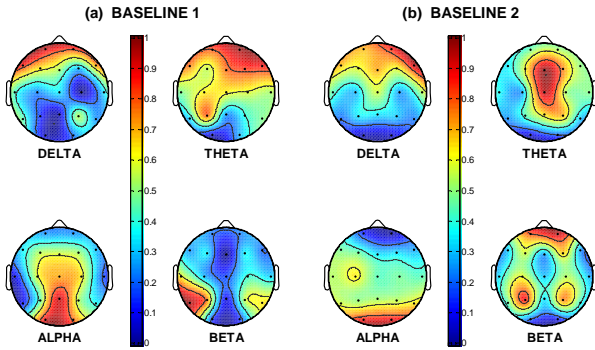


Fig 3 Topographic head maps (a) before and (b) after the practice

For comparing the actual changes in various rhythms between the stages, the percentage change in mean relative band power before and after practice was calculated and is shown in Fig 4.

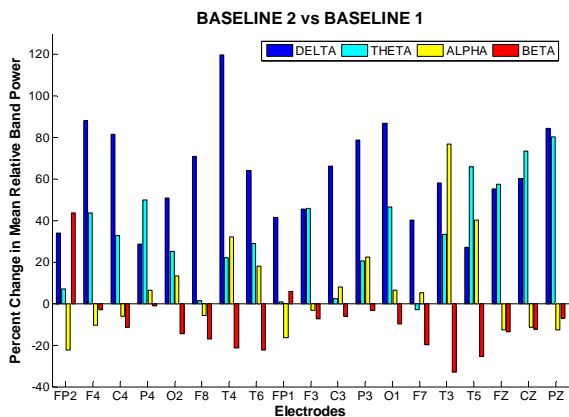


Fig 4 Percent change in mean relative band power before and after the practice

To test the effect of Shambhavi Mahamudra practice on the coherence between the hemispheres, the correlation coefficient values were computed between corresponding electrodes in both the hemispheres. Fig 5 shows the change in coherence values after the practice, with the significant changes starred. The progression of slow waves, delta and theta, between the two stages was also calculated as the ratio of Delta+Theta and Alpha for each electrode location (Fig 6).

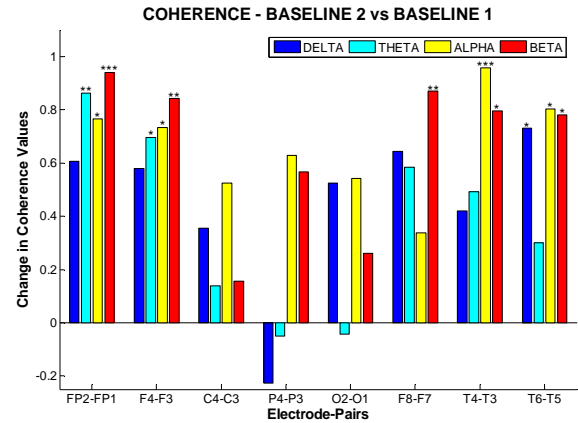


Fig 5 Change in coherence values before and after the practice [$*p < 0.05$, $**p < 0.005$, $***p < 0.0002$]

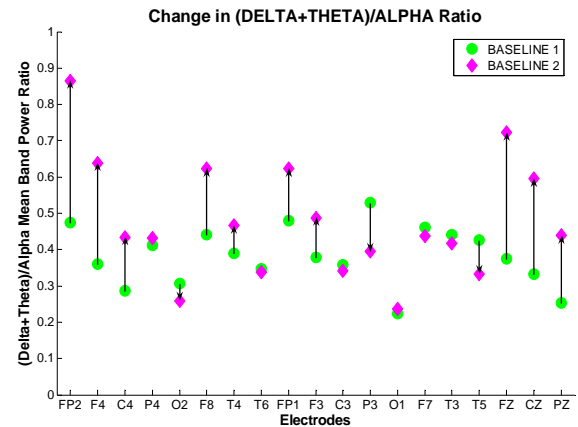


Fig 6 Change in (Delta+Theta)/Alpha mean band power ratio before and after the practice

For statistical analysis, one-way repeated measures ANOVA [11] was performed on the log transform (ln) of the absolute EEG band power to test possible differences between the two stages BASELINE1 and BASELINE2.

The entire spectral and statistical analysis of the recorded data was carried out using Matlab® 7.0 from The Mathworks Inc., USA.

3. RESULTS

Fig 2(a) showing the mean relative band power from the subjects before the Shambhavi Maha Mudra practice clearly shows that the alpha band power is very high at all the electrode positions, thus verifying that the Isha Yoga experts had high levels of relaxation in general.

As observed in Fig 4, there was a high increase in the delta band power (delta-F4: $p = 0.0128$; delta-F8: $p = 0.0326$) accompanied by an increase in theta band power throughout the entire hemisphere. It is to be noted that the simultaneous increase of these rhythms was maximum along the midline brain region. There was also a marked decrease in beta band power (beta-O2: $p = 0.0077$; beta-C3: $p = 0.0452$; beta-T3: $p = 0.0193$) almost throughout the entire hemisphere and a slight decrease in alpha band power in fronto-parietal and midline brain regions. It was seen that there was a maximum decrease in beta rhythm and a maximum increase in alpha rhythm in the temporal region simultaneously.

The changes in coherence between the left and right hemisphere depicted in Fig 5 clearly shows a significant increase in coherence throughout the entire cerebral region after the Shambhavi Maha Mudra practice. A high increase in progression of slow waves was also seen at most of the electrode positions (Fig 6).

4. DISCUSSION & CONCLUSION

The fundamental assumption that any mental experience has a corresponding electrical signature in the brain, which can be extrapolated from the electroencephalogram gave neuroscientists the view that mental and neural activities are highly correlated [4].

Certain EEG frequency bands were stated to indicate activity on different hierarchical levels as given in Table 1 [12].

TABLE 1: Possible sources of activity in certain EEG frequency bands

<i>Frequency Band</i>	<i>Activity</i>
Delta (δ)	Higher level of consciousness
Theta (θ)	Mental consciousness
Alpha (α)	Physical consciousness
Beta (β)	Specialized regions

Mental tensions, excitement and anxiety cause an increase in both amplitude and frequency of the beta rhythms. Alpha waves, which signify conscious awareness, are the bridge to the unconscious, which is represented by the lower frequencies, theta and delta. When one comes close to unconscious memories during deep

meditation, the theta activity tends to increase. In order to have conscious access to and remembrance of the unconscious content, alpha waves must be present in the EEG. Without alpha, the unconscious content remains unconscious [13]. For the present experiment, all subjects showed the presence of high alpha power in both the states.

Delta waves are associated with the deepest states of consciousness. Some consider that delta signifies contact with the collective unconscious. Delta rhythms combined with alpha are known to reflect an inner intuitive empathetic radar, a kind of sixth sense [13]. It is to be noted that there was a marked increase in Delta band power in all subjects after the practice.

A decrease in alpha power was reported in yogic meditation and Transcendental Meditation (TM). Also an increased theta, rather than an increase in alpha, was suggestive of proficiency in meditative practice [9].

EEG coherence is understood as a measure of cortical connectivity. Lower values of coherence are associated with white matter lesions and decreased cortical blood flow. Higher values of coherence have been interpreted as evidence of functional coupling, information exchange or functional coordination between brain regions. EEG coherence is also thought to be a likely predictor of other behavioral and physiologic accompaniments of meditation. Some authors have found significant correlation between EEG coherence as clearer experience of pure consciousness and higher scores on tests of creativity. Some have also reported correlations between coherence and IQ. Increased frontal coherence has been noted in TM, which reflects an enhancement of frontal lobe integration, as increased cognitive flexibility and intelligence and emotional stability [9].

In summary, the present experiment results, showing the considerable increase in delta and theta activity in most regions of the brain, indicate that the brain becomes deeply focused following Shambhavi Maha Mudra, thus reflecting higher level of mental consciousness. The reduction in the beta activity signifies lesser anxiety. Above all, the characteristic changes observed in this experiment established that all subjects showed a specific state effect of meditative practice.

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