Classification of Electrophotonic Images of Yogic Practice of Mudra through Neural Networks

Abstract

Background: Mudras signify a gesture with hands, eyes, and the body. Different configurations of the joining of fingertips are also termed mudra and are used by yoga practitioners for energy manipulation and for therapeutic applications. Electrophotonic imaging (EPI) captures the coronal discharge around the fingers as a result of electron capture from the ten fingers. The coronal discharge around each fingertip is studied to understand the effect of mudra on EPI parameters. **Methods:** The participants were from Swami Vivekananda Yoga Anusandhana Samsthana and Sushrutha Ayurvedic Medical College, in Bengaluru, India. There were 29 volunteers in the mudra group and 32 in the control group. There were two designs: one was a pre-post design with control the other was pre-post with repeated measures with 18 individuals practicing mudra for 3 days. The duration of intervention for the pre-post design was 10 min on the 1st day, 15 min on the 2nd day, and 20 min on the 3rd day. A neural network classifier was used for classifying mudra and control samples. **Results:** The EPI parameters, normalized area and average intensity, passed the test of normality Shapiro–Wilk. The Cohen's d, effect size was 0.988 and 0.974 for the mudra and control groups, respectively. Neural network-based analysis showed the classification accuracy of the post-intervention samples for mudra and control varied from 85% to 100% while the classification accuracy varied from 55% to 70% for the pre-intervention samples. The result of the mudra intervention showed statistically significant changes in the mean values on the 3rd day compared to the 1st day. **Conclusions:** The effect size of the variations in mudra was more than that of the control group. Mudra practice of a longer duration showed statistically significant change in the EPI parameter, average intensity in comparison to the practice on the 1st day.

Keywords: *Electrophotonic imaging, mudra, prana mudra*

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Introduction

Yogis use mudra for channelizing energy from the base of the spine (mooladhara) to top of the head (sahasrara). The physical-based sadhana, called hatha yoga, is the most widely known type of yoga. Kriya yoga uses visualization, gesture and ritual worship. Laya yoga explains how the concentrated mind can lead to forgetting the materialistic world and enjoy the Samadhi state. A mudra is a physical equivalent/ representation of a mantra. In hatha yoga, mudra is used for connecting two points of energy in our body.

A mudra can be perceived as a hand posture with a specific pattern of finger configurations. Using modifiers, complex mudras could be constructed from relatively simple mudras.[1]

The word "mudra" is derived from Sanskrit word Mud + Dhra or bliss dissolving meaning that which dissolves duality and brings the deity and devotee together. Mudras are hand, body, or eye positions that facilitate certain energy flows in the body and by forming a specific mudra one can induce certain states of mind and consciousness.[2]

According to custom mudras are typically used during meditation and pranayama as a way to direct energy flow throughout the body. In yoga philosophy, different areas of the hand stimulate specific areas of the brain. By applying light pressure to these areas of the hand, we will "activate" corresponding region of the brain, similar to reflexology. Mudras also symbolize various feelings, emotions, and representatives of various states of being.[2]

Hatha Yoga Pradipika deals with bandhas and mudras together and the ancient tantric texts also make no distinction between

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the two. Bandhas are extensively incorporated in mudra as well as in pranayama techniques. Their locking action, however, reveals them as a fundamentally important group of practices in their own right.[3]

Any living body is made of five distinct elements: Fire, wind, ether, earth, and water. These are the five building blocks that go into the formation of any living body. Several ancient health systems are based on the concept of the balance of the five elements. According to Ayurveda, an Indian medical science, distortion, or impairment of the 5 elements creates outer disturbance and inner sickness in the body. The five fingers of the hands represent these five elements: Thumb symbolizes fire, forefinger symbolizes wind, th middle finger for aether, ring finger for earth, and little or small finger symbolizes water.[4]

Prana mudra is formed by placing the tips of the thumb, ring finger, and little finger together. The other fingers remain extended. The prana mudra increases vitality, reduces fatigue and nervousness, and improves vision. It is used as an antidote for eye diseases. On the mental-emotional level, it increases our staying power and assertiveness, healthy self-confidence, gives us the courage to start something new, and the strength to see things through. Clear eyes are also a sign of a mental outlook emphasizing clarity and a clear mind, which means clearly structured thoughts and ideas.[4]

Electrophotonic imaging (EPI) instrument is used to capture coronal discharges at the fingertips induced by a pulsed electrical signal (10–15 kV, 1024 Hz, 10-µs) on the glass plate of a CCD camera. This device produces a type of digital high-voltage electrophotography that is based on the Kirlian effect.[5] The EPI is a noninvasive technique and is hazard free.[6]

The EPI instrument is based on the stimulation of electron emissions and consequent creation of photons from the surface of object. This process is called "photoelectron emissions" and it has been thoroughly studied with physical electronic methods. The emitted particles accelerate in the electromagnetic field, generating electronic avalanches on the surface of the dielectric (glass) plate. This process is called "sliding gas discharge." The discharge causes glow from the excitement of molecules in the surrounding gas, and this glow is what is being measured by the EPI instrument. Voltage pulses stimulate optoelectronic emission, while intensifying this emission in the gas discharge, amplified by the electric field created.[7]

EPI represents a spatially distributed glow areas having varying brightness characteristics, it reveals general-, local-, and sector-based details.[8] One of the main questions is to understand physical and psychological processes revealed by the measurement. Research shows that mental state and the psychic energy of a person could be measured.[9]

Artificial Neural Network is a model consisting of a set of processing units which are closely interconnected to each other such that a rich structure is formed which exhibits certain features of biological neural network. The fundamental unit of a biological neural network is a neuron and each neuron gets connected to other neurons using dendrites and axons at the synaptic junctions or synapses.[10]

Learning is the basis for pattern recognition. There are several algorithms defined for learning the patterns and the networks are trained using the learning algorithms to learn the patterns. The input and expected output pairs are defined as patterns which are used for training the network.[11]

During training phase, the network is excited with input patterns repeatedly and the weights of all the neurons are adjusted every time in such a way that the network learns all the patterns. At the end of the training, the patterns are stored in the form of weights in the network.[12]

The procedure to increment the weights of the neurons during the training phase is termed as learning and at the end of the successful training network can recall the pattern correctly from the weight vector.

There is a need for an automated study to observe the variations in all parameters with respect to a practice like mudra to understand its impact on the EPI parameters. The combination of EPI and neural network could be used as a framework for detecting the practice.

This is the first study using EPI data and artificial neural network for intervention detection. Given the subtle nature of intervention effect, and large number of variables generated, a sophisticated method of analysis is needed to capture the effect and hence this study helps in understanding the effect of prana mudra as stated in literature with the corresponding observations on the EPI parameters. We hypothesize that EPI parameters – area, normalized area, and entropy – are significantly different across mudra and control group and can be classified using neural networks.

Methods

The participants were from Swami Vivekananda Yoga Anusandhana Samsthana and Sushrutha Ayurvedic Medical College, in Bengaluru India. There were a total of 61 volunteers (39 males and 22 females) with mean age of 22.1 years. There were 29 volunteers in the mudra group (10 females, 19 males) and 32 (12 females, 20 males) in the control group. Pre- and post-test with control design was chosen during the first part of the study. After coming to the lab, the individuals were randomly assigned to either mudra group or the control group by asking them to pick a paper slip that has the group name.

Mudra group practiced prana mudra in the same sitting posture and for the same duration. The control group also followed the same procedure, except for not practicing the prana mudra, they sat quietly, closing their eyes for 5 min, in a similar sitting posture as described earlier. Pre- and post-assessments were made on both the groups.

The individuals were explained about the nature of the study and were given basic information about the EPI technique as well as the procedure for assessment. They had to keep all the ten fingers one by one on the glass surface of the EPI equipment and data recorded.

The second part of the study was a pre–post-repeated measures study with varying duration of prana mudra practice. The practice was for 10 min on the 1st day, 15 min on the 2nd day, and 20 min on the 3rd day.

The EPI variable, intensity, is a measure of the quantum activity of a subject, it is represented in computer units pixels, area measures the amount of light quanta generated by the subject in pixels it is a measure of metabolic rate. The variable entropy is the measure of chaos in regulation of biological and physiological functions.[13]

The EPI data were captured from all the ten fingers in sitting position. Informed consent was taken from all the subjects. This study was approved by the Institutional Ethical Committee.

Statistical analysis

In the first part, two group pre-post control design, an independent sample *t*-test was used to compare the means of the two groups mudra and control before and after the intervention. The effect size was also computed for all the four variables before and after the intervention.

In the second part of the design with varying duration of intervention, Paired sample *t*-test was used for comparing the means of the four variables before and after the intervention. Finally, the difference in the values of the variables before (pre) and after (post) intervention on the 1st day were compared with those of the 3rd day using the independent sample *t*-test. *P* < 0.05 was considered statistically significant. The results are reported to 3 decimal places.

A neural networks classifier with one hidden layer and four processing elements using the back propagation algorithm was used to classify the mudra and control groups.

The entire statistical analysis was performed with IBM SPSS Statistics for Windows, Version 20.0. (Armonk, NY: IBM Corp). The neural network classifier was also from SPSS version 20.

Results

Table 1 shows the baseline (pre) intervention values as well as the postintervention values for the EPI parameters for both the control and mudra groups. The baseline mean values for all the EPI parameters in the control group were significantly larger than the corresponding EPI parameter values for the mudra group.

The difference between pre- and post-intervention values for each of the variables was computed, and independent sample *t*-test was done on the difference variables for

the mudra and control groups. The independent sample *t*-test did not show a statistical significance between the means of difference variables between mudra and control groups.

The classification accuracy varied between 80% and 100% for post intervention samples as shown in Table 2 and the accuracy varied from 50% to 80% for the preintervention samples. Table 3 shows the best case values for both the samples.

The difference in pre-post intervention values of the 1st day were compared with the difference in pre-post intervention values of the 3rd day of mudra practice using independent sample *t*-test and the result is shown in Table 4. The mean value of the EPI parameters average intensity and entropy showed significant changes (*P* < 0.05), indicating the possible effect of mudra intervention. The effect size was high for the variable average intensity.

Table 1: The values of mean and standard deviation of the four variables area, normalized area, average intensity, and entropy for mudra and control groups

EPI parameters	Mudra (*n*=29)	Control (*n*=32)	*P**	ES
Area				
Pre	9847.93±18,705	10,194±1341	0.406	0.212
Post	10,621±1663	10,518±876	0.759	0.077
Normalized area				
Pre	1.87±0.71	2.64±1.2	0.003	0.780
Post	1.97±0.7	2.79±1.1	0.001	0.889
Average intensity				
Pre	73.5±4.9	78.6±5.6	0.001	0.971
Post	75.06±5.3	80.52±5.7	0.001	0.988
Entropy				
Pre	1.95±0.11	1.98±0.06	0.234	0.338
Post	1.95±0.11	1.98±0.05	0.222	0.351

Data are represented as mean±SD. Pre corresponds to the data before intervention and post corresponds to data after intervention. *P value comparing mean values of mudra and control for pre and post; significance at 0.05 using the independent sample *t*-test. *n* = Number of participants, ES = Effect size computed, SD = Standard deviation

Table 2: Classification accuracy of postintervention groups with one hidden layer and four processing elements using multilayer perceptron

Sample	Predicted		
	Mudra	Control	Percentage correct
Training			
Mudra	14	1	93.3
Control	0	14	100.0
Overall percentage	48.3	51.7	96.6
Holdout			
Mudra	7	0	100.0
Control	1	9	90.0
Overall percentage	47.1	52.9	94.1

The area under the curve for receiver operating characteristic=0.97

Table 3: Classification accuracy of preintervention groups with one hidden layer and four processing elements using multi-layer perceptron

Sample	Predicted		
	Mudra	Control	Percentage correct
Training			
Mudra	15	0	100.0
Control	1	16	94.1
Overall percentage	50.0	50.0	96.9
Holdout			
Mudra	7	0	100.0
Control	2	5	71.4
Overall percentage	64.3	35.7	85.7

Area under the curve for the receiver operating characteristics=0.86

Table 4: Comparison of pre-post difference in mean and standard deviations of the variables, area, normalized area, average intensity, and entropy on day 1 and day 3

EPI parameters	Day 1_pre_ post difference	Day 3_pre_ post_difference	P^*	ES
Area	517.7±851	115±1027	0.052	0.426
Normalized area	0.115±0.75	0.323±0.68	0.075	0.29
Average intensity	−3.6±5.4	0.73±4.6	0.013*	0.86
Entropy	0.045±0.07	−0.0076±0.05	0.022*	0.509

Independent sample *t*-test $P<0.05$ for average intensity and entropy. EPI = Electro photonic imaging

Discussion

Mudras are used for energy manipulation in one's own body. The energy manipulation will have both immediate and long-term effects. This paper has studied the immediate effect just after the intervention and also on the 3rd day of the intervention.

The first part of the experiment was to study the difference between sitting quietly with eyes closed with attention on breath (control group) with that of sitting quietly applying prana mudra (mudra group) and taking attention on the breath. This practice done for 5 min had a consistent change in effect size for the three variables normalized area, average intensity, and entropy. Change in this variable is an indication of possible energy manipulation.

The difference between mudra and control was very subtle from the activity perspective. Both the groups were sitting idle, the only difference was in adopting the mudra. Just sitting Idle with or without the mudra also caused a significant change in one of the EPI parameters. This change can be verified with a longer duration of sitting idle to detect an idle condition from other intervention.

The increased effect size for mudra is an indication of a possible chance of recognizing this intervention from the control when the experiment is repeated for a longer duration. The neural network-based classification was

able to classify the mudra and control groups after the intervention more accurately than before the intervention.

The baseline values of the EPI parameters of both the groups were not equal though the control and mudra grouped matched well with respect to age and health status. This discrepancy was taken care of by computing the difference in EPI parameters between the pre- and post-intervention values for the control and mudra groups and then carrying out the independent sample *t*-test. The statistically significant difference in the means of the variable average intensity demonstrates the effect of mudra on the level of quantum activity or the inner energy,

The second part of the experiment which involved repeating the mudra intervention with varying duration for 3 days showed a statistically significant difference in the EPI parameters average intensity and entropy ($P < 0.05$) on the 3rd day compared to the 1st day. The difference in pre-post values of the 1st day was compared with the 3rd day. This is an indication that mudra must be practiced for more than 20 min in one sitting to see an appreciable change.

It is said that prana mudra is used for curing eye related problems. In future studies, the EPI parameters can be extracted for the related organs such as the eye to see the corresponding changes.

Conclusions

Adopting a mudra and sitting quietly with eyes closed for 5 min did not have a big difference in the EPI parameters. However, mudra practiced for a longer time showed a significant change in the mean value of the EPI parameter average intensity. Mudra must be practiced for more than 20 min in one sitting for observing a detectable change in the EPI parameters.

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Conflicts of interest

There are no conflicts of interest.

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