



# QUANTITATIVE ANALYSIS OF EEG SIGNAL BEFORE AND AFTER SUDHARSHANA KRIYA YOGA

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## Abstract

*From ancient period, meditation has been practiced by the people. Originally, it was meant to deepen the understanding of the sacred and mystical forces of life. In today's fast life, significant amount of mental stress due to hectic work schedules is leading to psychological disorders, insomnia, depression and many other problems. In the past, many people who have done research on meditation have found out the effect of meditation on stress relief and disease improvement.*

*In relation with EEG signals, a lot of work has been done to find the significant changes between the signals and mental states by using different methodologies. This work is mainly designed to trace the varying spectral characteristics of EEG during meditation and then the changes of EEGs during meditation are to be analyzed using Quantitative analysis. In this work, EEG data of 43 subjects who practice Sudharshana Kriya Yoga have been collected and comparison of the amount of stress and relief before and after performing Sudharshana kriya yoga is calculated. After the analysis, it is found that, the long term practitioners show improved energy in the EEG components by 2-fold to 3-fold whereas, the short term practitioners have shown relatively less improvement. Improved energy value in alpha wave indicates that the person is relaxed and increase in beta component mean alert to the external world. Improved energy in theta indicates that the person is in extreme relaxation state. 90% of the subjects shown increase in alpha and beta values after meditation. This work draws the conclusion that, the person is in extreme relaxation state and is alert to the external world. Also, meditation can transform man's life and take him out of stress and provide him relaxation and stress-free life.*

**Keywords-** EEG, Sudharshana kriya yoga, Quantitative analysis.

## I.INTRODUCTION –SUDHARSHANA KRIYA YOGA

Sudharshana Kriya is a powerful yet simple rhythmic breathing technique that incorporates specific natural rhythms of the breath, harmonizing the body, mind and emotions.

The technique eliminates stress, fatigue and negative emotions such as anger, frustration and depression, leaving the mind calm, focused and the body energized, completely relaxed. Sudharshana Kriya brings a profound depth of life, unraveling its mysteries. It's spiritual breakthrough giving the experience of a glimpse of infinity. It is the unrevealed secret of health, happiness, peace and an insight of the life beyond.

## LITERATURE AND SURVEY

A group analysis on Transcendental Meditation effects is done by Jean Philippe Lachaux and Eugenio Rodrigue by EEG Coherence Analysis. Richard J Davidson and Antoine Lutz, University of Wisconsin-Madison have analyzed OM Meditational techniques effects on EEG for 2 subjects, and conclusions made by Manual observation of increase in alpha activity in the EEG signals. Estimations of effects of Nada Anusandhana meditation effects on EEG is performed by Vijayalakshmi, Appaji Abhishek and conclusions are made by quantitative analysis. EEG Analysis during Sudarshana Kriya is studied by M Bhatia on 5 subjects using Coherence Analysis. Michael R Hagerty and Julian Isaacs done on EEG coherence analysis of an Expert Meditator in Eight Jhanas by using Power Analysis.

From the literature survey it is observed that in all the experimental studies authors have concluded the results by indicating increase in alpha activity after meditation, but fails to give the results in quantitative and also number of samples



considered for the study is less than Thirty . This made us to perform detailed quantitative analysis to analyze the effects of sudarshana kriya on EEG signals .

## II. DATA ACQUISITION AND ANALYSIS

EEG signals are acquired from 43 normal subjects using Recorders Medicare 10-20 System with 24 channel digital EEG machine having an A/D conversion of 16 bits with sampling frequency of 256Hz, Software version: Super Spec 4.2.54. EEG signal acquired using Electrode placement as in figure1.

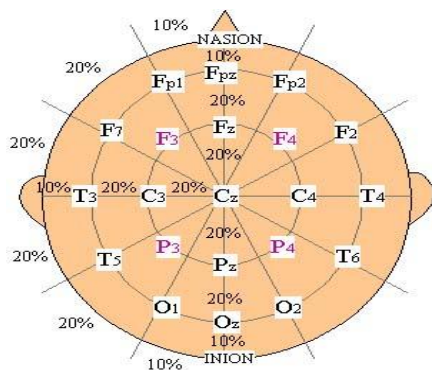


Figure 1: Standard 10-20 EEG Electrode Placement

Figure 2 and 3 shows the display of 18 channel EEG signals before and after Sudarshan Kriya for one subject. x-axis denotes number of samples and y-axis denotes signal amplitude in micro volts.

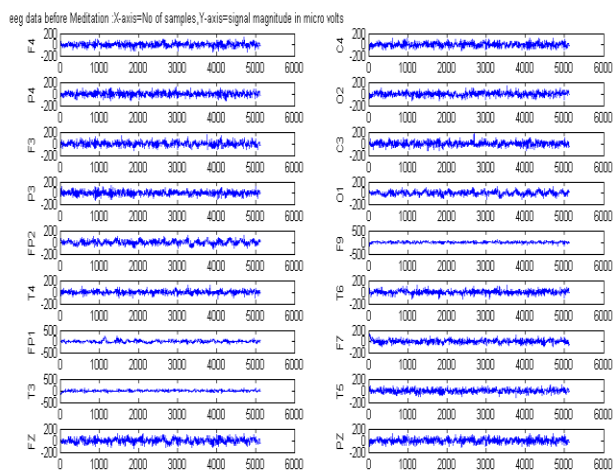


Figure 2:EEG signals Before Sudarshana Kriya

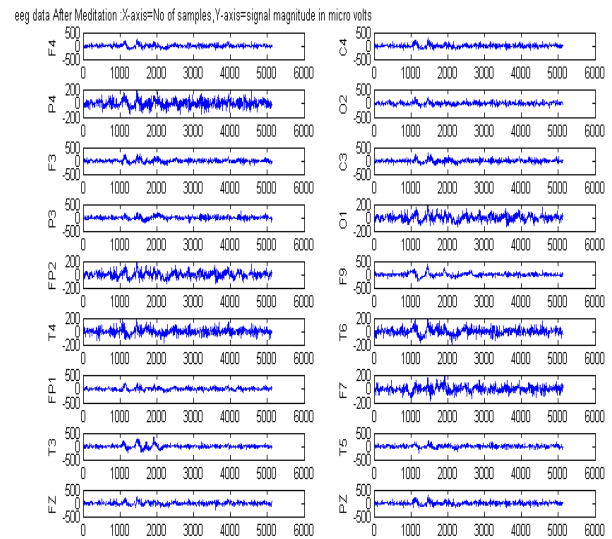


Figure 3:EEG signals after Sudarshana Kriya

Brain waves have different frequency components as alpha,beta,delta,theta and gama waves.

Delta waves are between zero and less than 4Hz which are present during deep dreamless sleep. Theta waves are 4-7Hz found during extreme relaxation, Alpha waves are 8-12Hz, accours during awake but relaxed, Beta waves are 13-40Hz accounts for Normal waking consciousness [1-3].

EEG signals were acquired for forty three normal subjects between the age group of 25-40 years. Ten of them are practicing Sudharshana kriya yoga for more than eight years, considered as long term Practitioners; otherwise taken as short term practitioners, 24 of them are male and others, female practitioners, 8 of them are teacher and others are not teachers.

## III. PROPOSED METHODOLOGY

The following flow chart shows the steps taken in this work to perform the analysis.

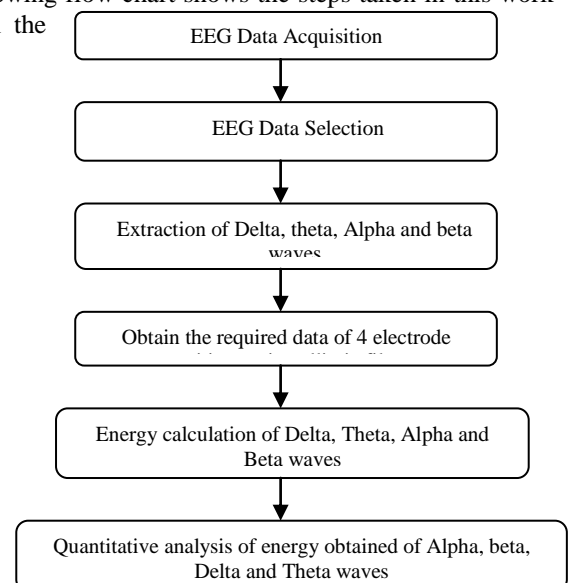




Figure 4: EEG signal processing steps

In clinical electroencephalography, 21 electrodes are used to place on a scalp, it is known as 10-20 system, 19 scalp and 2 earlobe (auricular) electrodes are used to examine the electrical activity of the surface of the brain. The electrodes placed on the scalp of the subject, pick up the EEG signal. In this study we have made analysis for four electrode positions two from frontal regions of the scalp and two from occipital regions of the scalp, namely FP1, FP2, O1 and O2 respectively. EEG data for 20 seconds are considered for analysis. EEG data is filtered with elliptic filters to get its associated frequency components. Energy for the filtered components are calculated which are used for comparison between the subjects [4-5].

**IV. RESULTS AND CONCLUSIONS**

Result for subject 1 as a bar graph is as indicated in figure 5.

Terminologies:

FP1B: Left electrode position at pre frontal before meditation. FP2B: Right electrode position at pre frontal before meditation. O1B: left electrode position at occipital before meditation. O2B: Right electrode position at occipital before meditation.

FP1A, FP2A, O1A, O2A → electrode positions after meditation

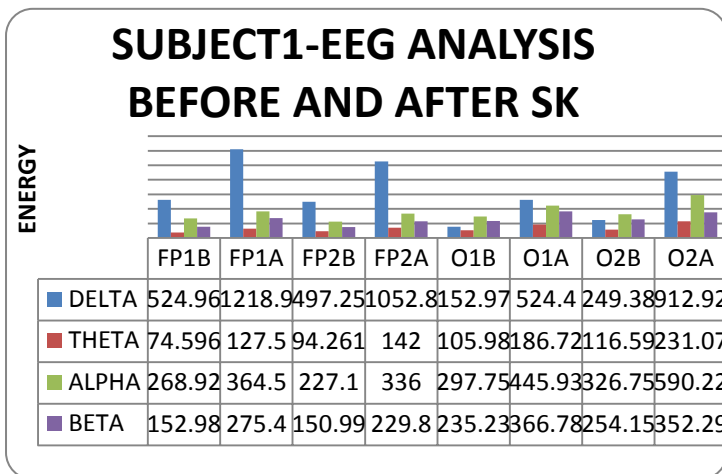


Figure 5: Left and Right brain activity before and after sudarshan kriya.

From Energy calculation it is found that Initially, most of the subjects were not in relaxed state. After meditation it is found that, all of them have shown predominant increase in the energy. Observing the Energy levels at all the four frequency components at 4 electrode positions, about 84% of subjects show increase in alpha energy. About 97% of them showed increase in beta energy, 88.4% of them show increased energy in Delta waves and finally 100% results are shown in case of Theta waves' energy. All ten of the long term practitioners show improved energy by 2-fold and 3-fold whereas, the short term practitioners have shown relatively

less improvement in energy. On an average, 42% of the subjects show increased energy in all 4 electrode positions. Improved energy value in alpha and beta waves indicates that the person is alert to the external world, even when the person is meditating. Improved energy value in beta wave indicates that the person is in normal waking consciousness, delta wave for deep sleep and finally, improved energy in theta indicates that the person is in extreme relaxation state.

On the whole, the person is in extreme relaxation state and is alert to the external world. This work draws the conclusion that, the right part of the brain is more active than left part of the brain since maximum increase in energy is shown in O2 and FP2, which are pre-frontal and occipital regions of right part of the brain. Second one is that, meditation can transform man's life and take him out of stress and provide him relaxation and stress-free life.

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**REFERENCES**

[1] Niedermeyer E. and da Silva F.L. (2004). *Electroencephalography: Basic Principles, Clinical Applications, and Related Fields*. Lippincott Williams & Wilkins. "EEG"

[2] Haas, L F (2003). "Hans Berger (1873-1941), Richard Caton (1842-1926), and electroencephalography". *Journal of Neurology, Neurosurgery & Psychiatry* **74** (1):9

[3] Schlögl, Alois; Slater, Mel; Pfurtscheller, Gert (2002). "Presence research and EEG".

[4] Schreckenberger, Mathias; Lange-Asschenfeldt, Christian; Lochmann, Matthias; Mann, Klaus; Siessmeier, Thomas; Buchholz, Hans-Georg; Bartenstein, Peter; Gründer, Gerhard (2004). "The thalamus as the generator and modulator of EEG alpha rhythm: A combined PET/EEG study with lorazepam challenge in humans". *NeuroImage* **22** (2): 637-44.

[5] Towle, Vernon L.; Bolaños, José; Suarez, Diane; Tan, Kim; Grzeszczuk, Robert; Levin, David N.; Cakmur, Raif; Frank, Samuel A.; Spire, Jean-Paul (1993). "The spatial location of EEG electrodes: Locating the best-fitting sphere relative to cortical anatomy". *Electroencephalography and Clinical Neurophysiology* **86** (1): 1-6.

