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EEG changes during acute alternate nostril breathing exercise in healthy adult male

Sanjay Maharjan[1], Rita Khadka[2], Bishnu Hari Poudel[3], Nisha Ghimire[4], Prem Bhattarai[5], Nirmala Limbu[3]

[1]Lecturer, Department of Physiology, Patan Academy of Health Sciences, Lalitpur, Nepal
[2]Additional Professor, Department of Basic and Clinical Physiology, B.P. Koirala Institute of Health Sciences, Dharan, Nepal
[3]Professor, Department of Basic and Clinical Physiology, B.P. Koirala Institute of Health Sciences, Dharan, Nepal
[4]Assistant Professor, Department of Physiology, Nobel medical college, Biratnagar, Nepal
[5]Lecturer, Department of Physiology, Birat medical college, Biratnagar, Nepal
Corresponding author: **Sanjay Maharjan,**
Department of Physiology, Patan Academy of Health Sciences, Lalitpur, Nepal
E-mail: *maharjan.dr@gmail.com*

Abstract

Background and objectives: There are very few studies investigating the acute effects of alternate nostril breathing (ANB) on EEG. We aimed to investigate the changes in EEG before, during and immediately after alternate nostril breathing.

Methods: This study was conducted on consenting 10 healthy non yoga practitioner male age 28.33±1.41 years in B.P. Koirala Institute of Health Sciences, Dharan. They were orientated about alternate nostril breathing. EEG was recorded next day before, during and after the alternate nostril breathing exercise. Artifact free 5 EEG epochs of 5-second of each event were analyzed by fast Fourier transformation to obtain frequency components. Friedman test and Wilcoxon Sign Rank test were applied to compare the changes in EEG waves (delta, theta, alpha and beta) among the events. Data are expressed as median with inter-quartile range.

Results: Compared to pre-ANB, there was a significant decrease in the theta power during ANB exercise [24.5(16.86-28.34) vs. 15.32(11.36-18.02) μV^2, p =0.018] in left parietal area. Similarly, beta power was decreased after ANB compared with during ANB [7.16(4.44-10.68) vs. 10.72(7.64-13.52) μV^2, p=0.018] in right frontal area. There were no any significant changes in alpha and delta waves among the events.

Conclusion: Alternate nostril breathing exercise effect the brain waves activity in terms of stimulation theta and beta waves which have been suggestive of alertness of mind during exercise.

Keywords: alternate nostril breathing, nadi shodhana pranayam, electroencephalogram

Introduction

With the increased awareness and interest in health and natural remedies, yogic techniques including Pranayama are gaining importance. Pranayama is generally considered to mean regulated breathing.[1] Alternate nostril breathing (ANB) is the techniques of Nadi shodhana Pranayama consists of slow, deep, quiet breaths using one nostril at a time.[2]

Several previous studies on different technique of Pranayama showed changes in Electroencephalogram (EEG) waves. SrinivasanT reported that different types of Pranaymas stimulate different specific receptors in the body, each of which have, in their turn, specific frequency of localization in the brain.[3] About ANB, Barnwal S et al observed increase in alpha EEG band after 30 days of ANB practice.[4] Satancak A et al. in their study observed increase in mean power beta bands and partially in the alpha band increased during 10 minutes of Force ANB. In addition, Forced ANB has balancing activity on left and right hemisphere.[5]

There are very few studies investigating the immediate effects of ANB in EEG. Due to changes in the urban lifestyle it is a very common practice these days to perform yogic technique like breathing exercise to reduce stress.[6] Therefore, recording EEG during and immediately after the alternate nostril breathing exercise would provide the neurophysiologic basis of it.

Materials and Methods

Subjects:

The study was conducted on 10 healthy non yoga practitioner male with age 28.33±1.41 years in the Neurophysiology Laboratory, Department of Basic and Clinical Physiology, B.P. Koirala Institute of Health Sciences, Dharan, Nepal. Subjects with any cardio-respiratory problem/disease or physical disabilities, suffering from seizure disorder and using or having any other drug/disorder that might affect EEG were excluded from the study.

Procedure:

The experimental protocol consisted of the EEG recording during rest, exercise and recovery. Before recording day, subjects were taken written consent, and given orientation about the alternate nostril breathing exercise. In the recording day, subjects were advised to come with a clean scalp without oil after two hours of light meal between 9 am to 11 am. Room temperature of the laboratory was maintained at 26±2°C. The subjects were familiarized with the laboratory set up. The EEG electrodes (Nihon Kohden) were placed at mid-frontal (F3-F4), temporal (T3-T4), central (C3-C4), parietal (P3-P4), and occipital (O1-O2) regions following the International 10-20 System of Electrode Placement. The reference electrodes were placed on the left and right earlobe (A1 & A2). These electrodes were connected to the 16-channel digital EEG machine (Nihon Kohden-Neurofax: Optiplex GXMT 5120). Impedance of electrodes was maintained at less than 5 kilohms.

Anthropometric and cardio respiratory variable including resting heart rate were recorded using standard protocol before staring the EEG.The resting EEG was recorded in a sitting position with eyes closed, relaxed condition. It was recorded till the alpha waves were observed (most of the recording at least for 5 min). Then, the subjects started to do alternative nostril breathing for 10 min and EEG recording was recorded during the procedure. After exercise, recovery EEG was recorded with eyes closed and recorded till heart rate reached the baseline level.

Statistical analysis:

The EEG records were inspected visually for artifacts. Then, artifact free six sec five epochs were selected randomly from each of the pre, during and post ANB exercise sections of the record. Fast Fourier transformation (FFT) was performed on these data for power spectral analysis. The EEG power obtained from each epoch was averaged. Statistical analysis was done using SPSS (version 16). EEG powers (μV2) are presented as median and inter quartile range.

A P value of < 0.05 was considered as statistically significant. Overall comparison of EEG data were done by Friedman's test and multiple comparisons between pre-ANB and during ANB, during ANB and post ANB, pre- ANB and post ANB) by Wilcoxon's Sign Rank Test.

Alternate nostril breathing technique: [7]

1. Open the right hand and bend index and middle fingers against the palm. The thumb was used for closing the right nostril while the fourth and fifth fingers were used for the left nostril.

2. Place the right thumb against the ala at the end of the nostril to close it and similarly press the fourth and fifth fingertips against the left nostril.

3. Start the exercise in the comfortable position with relaxed attitude and concentration with right and left nostril breathing alternatively.

Results

The mean age of the subjects was 28.33±1.41 years. All the subjects were looked upon for their anthropometric and other cardiovascular parameters including resting systolic blood pressure, diastolic blood pressure and heart rate. The results are expressed as Mean±Standard deviations are presented in table 1.

Table 1. Anthropometric and cardiovascular parameters

Variables	Mean± SD
Age in years	28.33±1.41
Height (meter)	1.72±02
Weight(kg)	70.88±6.03
Body mass index	23.8±2.6
Resting systolic B.P (mmHg)	125.77±6.35
Resting diastolic B.P (mmHg)	74.44±6.1
Resting Heart rate	72.11±6.91

The EEG of the subjects were recorded in three states i.e. pre ANB, during ANB, after ANB. There is significant change in beta (F8, T6, P4 electrode) and theta (P3 electrode) waves when overall comparison is done among the events by Friedman test.

Wilcoxon's Sign Rank Test was used for multiple comparisons. Compared to pre-ANB, there was a significant decrease in the theta power during ANB exercise [24.5(16.86-28.34) vs. 15.32(11.36-18.02), p =0.018] in left parietal area. Similarly, beta power was decrease after ANB compared with during ANB [7.16(4.44-10.68) vs. 10.72(7.64-13.52), p=0.018] in right frontal area. The results of beta wave are expressed in table 2 and theta waves in table 3.

There were no any significant changes in alpha and delta waves among the events.

Table 2. Beta waves overall comparison of the events (p1), comparisons between pre-ANB and during ANB (p2), during ANB and post ANB (p3), pre- ANB and post ANB (p4)

Electrode	Before ANB Median (Q1-Q3)	During ANB Median (Q1-Q3)	After ANB Median (Q1-Q3)	p1	p2	p3	p4
F8	7.42 (5.78-8.32)	10.72 (7.64-13.52)	7.16 (4.44-10.68)	**0.05**	0.310	**0.018**	0.612
T6	12.84 (10.28-21.64)	18.54 (16.86-24.54)	12.54 (9.90-21.88)	**0.05**	0.237	0.063	0.735
P4	17.40 (11.24-50.10)	21.50 (19.64-36.28)	16.08 (12.44-48.84)	**0.05**	0.237	0.735	0.237

F8 = frontal right electrode, P3 = parietal left electrode, P4 = parietal right electrode, T6 = temporal right electrode, p = p value, Q1-Q3 = inter quartile range

Table 3. Theta waves overall comparison of the events (p1), comparisons between pre-ANB and during ANB (p2), during ANB and post ANB (p3), pre- ANB and post ANB (p4)

Electrode	Before ANB Median (Q1-Q3)	During ANB Median (Q1-Q3)	After ANB Median (Q1-Q3)	p1	p2	p3	p4
P3	24.50 (16.86-28.34)	15.32 (11.36-18.02)	14.68 (14.28-25.40)	**0.05**	**0.018**	0.63	0.398

Discussion

Due to the advancement of technology & the information overload, it is hard to maintain balanced state of mind & to remain always free from stress and anxiety. Breathing exercises part of yoga, believed to have a beneficial effect on physical as well as mental health.[8-10] Study on alternative nostril breathing has shown that it synchronize the activities of two hemispheres, increase in alpha and beta power in the EEG.

Barnwal S studied the impact of alternate nostril breathing after 30 days of ANB on EEG. The result showed a significant change positively increased the Alpha EEG waves in the exercise group.[4] Satancak A et al. studied EEG changes during 10 min force alternative nostril breathing (FANB) in trained subjects. Mean power in the beta bands and partially in the alpha band increased during FANB.[5] Our result match with that of Satancak, as beta power band is increase during ANB. Previous studies which is done in trained and chronic effect of ANB showed significant increase in alpha bands. There were no any significant changes in alpha as well as delta waves in our studies.

Beta waves occur during heightened state of awareness. Increase in beta waves correlated with increase in cognitive skills. Along with cognition beta waves is associated with decrease in fatigue and anxiety.[11] Theta waves indicate drowsiness, first steps of sleep, day dreaming.[12] Most of the research related increase theta activity with relaxation.[11] In our studies there increase in beta activity during ANB compare with after ANB. Also, decrease in theta activity during ANB compares with before ANB stage; both of these findings are suggestive of alert stage of mind during ANB exercise. However, the limitation of the study was the nature of the sample present in our study. Further studies are needed, which would provide more scientific background of it.

Conclusion

Alternate Nostril Breathing exercise is a powerful breathing practice. It affects the brain waves activity in terms of stimulation theta and beta waves which have been suggestive of alertness of mind during exercise.

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