

Neurophysiological Changes Determined by the EEG with Yoga Breathing Practices: A Mini Review

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Received: July 10, 2018; Published: August 28, 2018

Abstract

Yoga is a mind body intervention which helps to attain a calm and stable mental state. In yoga, voluntary breath regulation is given importance as it acts as a bridge between the brain and the rest of the body. There are several studies which reported changes in EEG caused by yoga breathing practices. Thirty one studies from the year 2000 to the present, from PubMed were reviewed here. Two studies fulfilled the criteria for inclusion. The summary of these studies is that yoga breathing practices can alter the EEG by decreasing theta and beta band frequencies, suggestive of better attention and relaxation. However, there are several limitations which are discussed.

Keywords: EEG; Yoga Breathing Practices; Relaxation

Abbreviations

EEG: Electroencephalography; ERP: Event Related Potentials; EP: Event potentials; ANYB: Alternate Nostril Yoga Breathing

Introduction

Yoga is a mind body practice which is increasing in popularity world-wide. An important component of yoga is breathing which is described as a bridge between the mind and body. There are a number of breathing techniques practiced in yoga called pranayama (in Sanskrit). Yoga breathing is described as a method to achieve mental tranquility in yoga texts [1]. The text describes the association of breath with the mind in a verse as “when the prana (breath) is irregular the chitta (mind) is unstable, when the prana is without movement the chitta is stable (Hatha Yoga pradiipika, Chapter II, Verse 2).

Electroencephalography (EEG) is commonly used to assess changes in the mental state [2]. Recording the electrical activity generated by voltage fluctuations from the ionic flow provides a quantitative and non-invasive approach to study brain functions. Studies suggest the neurophysiological effects of yoga breathing practices. This mini review is aimed to discuss the neural changes associated with yoga breathing practices determined by the EEG recordings.

Materials and Methods

Studies exclusively assessing yoga breathing practices and the EEG were included in the review. PubMed was searched using the search terms “EEG and Yoga breathing”. A total of thirty-one studies were found. The exclusion criteria were (i) studies published before the year 2000 (16 excluded), (ii) practicing other yoga techniques as well (e.g., postures, meditation) (8 studies excluded), (iii) review articles (4 studies excluded) and (iv) studies on ERP or EP other than EEG (1 study excluded). Two studies met the inclusion and exclusion criteria and were reviewed in the present study.

Results

One study reported changes in the EEG after alternate nostril yoga breathing (ANYB) [3]. As the name implies this practice involves breathing through the nostrils alternately. The study included 13 healthy males with 6 months experience of ANYB, who were allotted to three sessions randomly on three consecutive days at the same time of the day. The three sessions were (i) alternative nostril yoga breathing, (ii) breath awareness and (iii) quiet sitting; each for 18 minutes. The recordings were at FP1, FP2, C3, C4, O1 and O₂ sites of scalp according to the 10 - 20 system of electrode positioning. There was a 19.4 % and 21.2 % decrease in theta band energy at occipital (O₂, $p < 0.05$) and central sites (C4, $p < 0.05$), respectively during ANYB. Amplitude of the beta band was decreased by 9.6% after ANYB at occipital sites (O₂, $P < 0.05$). In addition, there was a 14.3% increase in the beta band energy at the right frontal area (Fp2, $p < 0.05$) during quiet sitting, along with a 8.9% decrease in alpha band amplitude on the right side centrally (C4, $p < 0.05$).

The other study with a pre and post design reported that bumble bee breathing can generate high-frequency gamma waves [4]. This practice involves slow, long and deep respiration along with producing a vibrating sound while exhaling through the nostrils. The sound produced resembles the buzzing of bumble bees, hence the name. There were eight subjects, among whom one had four months of experience of practicing bumble bee breathing and one had no experience of this practice. The remaining subjects had one month of experience of bumble bee breathing. There were 20 rounds of bumble bee breathing with EEG recorded from 128 active electrodes. All subjects exhibited high-frequency biphasic paroxysmal gamma waves during humming. The large amplitude peaks ($\pm 10 - 30 \mu\text{V}$) were seen at a sustained fast rhythm of approximately 10 - 30 Hz. Besides this, there was a trait of increased theta activity ($P < .05$).

Discussion and Conclusion

There are different methods of breath regulation described in yogic texts. The two studies reviewed here suggest that yoga breathing leads to definite changes in the brain as measured by EEG recordings. During the practice of alternate nostril yoga breathing there was a reduction in theta band energy at occipital and central sites, along with a decrease in the amplitude of the beta band at occipital sites [3]. A study suggested that a tonic increase in alpha and a decrease in theta power was related to better memory and is related to complex cognitive functions [5]. Another study reported that anterior and frontal midline theta reflected an emotionally positive state and internalized attention [6]. However, the theta activity increases in drowsiness which can decrease the performance in cognitive tasks [5]. Hence alternate nostril yoga breathing could be associated with better performance in cognitive tasks but this cannot be concluded firmly. Alternate nostril yoga breathing also lowered the beta amplitude at occipital sites. This could suggest decreased alertness, arousal and excitement which are associated with increased beta wave activity [7], though beta wave activity and its functional correlates are not well understood [8]. Interestingly, sitting quiet for a duration of 18 minutes increased beta band energy at frontal sites along with a decrease in alpha band amplitude at centrally. The arousal based theory of beta activity relates increased beta activity with increased mental activity or arousal [9]. This along with the reduction seen in alpha amplitude could be due to raised arousal and a state of mind wandering, because subjects were given no tasks to do except to sit quietly as a control.

Bumble bee breathing produced high-frequency biphasic ripples of paroxysmal gamma waves during the practice [4]. These were large amplitude voltage transients of about $\pm 10 - 30 \mu\text{V}$ occurring at a fast rate of approximately 10 - 30 spikes/sec. Similar to this paroxysmal gamma wave phenomenon, high-frequency gamma waves of unusually large amplitude were seen in trained practitioners of Buddhist meditation [10]. There was a basic trait of increased theta range activity for bumble bee breathing. This is similar to results of meditation techniques which were associated with a thoughtless blissful state [11]. The bumble bee breathing practice may hence be associated a more quiet mental state.

Both the studies reviewed here have some limitations such as lack appropriate controls and small sample sizes. Hence, the two breathing practices can be said to have beneficial effects on the brain and mental state while in the absence of larger sample sizes and proper study designs, this cannot be said conclusively.

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Volume 10 Issue 9 September 2018

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