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THE EFFECT OF LEFT UNILATERAL FORCED NOSTRIL BREATHING ON CARDIO-VAGAL AUTONOMIC ACTIVITY.

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ABSTRACT Unilateral forced nostril breathing can influence the autonomic nervous system. The aim of the present study was to evaluate the influence of left unilateral forced nostril breathing practice of 2 minutes for one week on the cardio-vagal activity. The cardiovagal activity was studies before and after the breathing practices among 50 men in the age group between 18 and 30 years. The battery of autonomic test performed was resting heart rate, E:I ratio, Valsalva ratio and 30:15 ratio for standing. Paired "t" test and Wilcoxon signed ranked test was performed for parametric and non-parametric data respectively. All the autonomic tests reflected increased vagal activity which were statically significant ($p<0.001$). Our study supports the hypothesis that by manipulating the nasal cycle the autonomic activity can be altered. Further research in unilateral forced nostril breathing can help patients with dysautonomia.

KEYWORDS : Unilateral nostril breathing; Autonomic function test; Valsalva ratio; Yoga breathing technique; Vagal tone.

INTRODUCTION:

The rhythmic or cyclical change in biological activity is an essential function exhibited by all living forms ranging from sub-cellular organelles to whole organism (Rusak and Zucker 1975). During breathing, the nasal airflow is greater in one nostril than in the other due to transient nasal passage obstruction by erectile tissue in the nasal cavity. This dominance in airflow that alternates between the nostrils is known as the nasal cycle (Hasegawa and Kern 1977). This nasal cycle was first observed and named by R Kayser in 1895 (Stoksted 1953). The nasal cycle was evident across mammalian species where it was investigated (Bojsen-Moller and Fahrenkrug 1971; Asakura et al. 1987). The physiological role of this nasal cycle is claimed for the nasal mucociliary clearance (Soane et al. 2001) thereby preventing respiratory infection (Eccles 1996). The nasal cycle has an ultradian rhythm with duration ranging from 25 minutes to 8 hours with a longer period on the left nostril. (Atanasov 2014; Hasegawa and Kern 1977). The earliest ultradian rhythm observed was in the fetal motor activity (Granat et al. 1979) which is one of the "basic activity rest cycle" (BARC) postulated by Kleitman (Kleitman 1982). The nasal cycle duration is shorter during wake period, when compared to sleep. It is also influenced by body posture as well as by age (Kahana-Zweig et al. 2016).

The physiological mechanism underlying this nasal cycle is not well understood, albeit, one of the physiological attributes of the nasal cycle is the lateralization of cerebral hemisphere mediated through the autonomic nervous system, with sympathetic being active during right nostril dominance and parasympathetic during left nostril dominance (D. Shannahoff-Khalsa 1991). However, though nasal cycle was postulated to be controlled by autonomic nervous system, it was observed even among patients with dysautonomia (Ishii et al. 1993). This nasal cycle has been explored in yogic science as breathing practices to influence physiological parameters. Scientific evidence approves of this theory that forced nostril breathing practice can influence physiological parameters like blood pressure (Raghuraj and Telles 2008). Studies have also documented that unilateral forced nostril breathing through different nostrils can influence the autonomic nervous system differently, with right forced nostril breathing (RFNB) enhancing sympathetic and left forced nostril breathing (LFNB) parasympathetic nervous system (D. S. Shannahoff-Khalsa and Kennedy 1993). However, there are also conflicting evidence to validate that unilateral forced nostril breathing influences the contralateral cerebral hemisphere (Schiff and Rump 1995; Werntz et al. 1987) and ipsilateral hemisphere (Block et al. 1989). Unilateral breathing practices, through both right and left nostril, for 10 days showed improvement in spatial memory, which is a function of right hemisphere, without cerebral lateralization (Naveen et al. 1997). Since cerebral lateralization is apparent in the autonomic nervous system, with the right hemisphere linked to parasympathetic and the left hemisphere to sympathetic (D. Shannahoff-Khalsa 1991), the influence of unilateral forced nostril breathing on the autonomic system can be debated. Our literature search showed that data on the effects of unilateral forced breathing on standard battery of autonomic function tests are scarce. We hypothesized that left unilateral forced nostril breathing (LUFNB) will enhance parasympathetic activity and designed a study to elucidate the residual effect of one-week (LUFNB) practice on standard cardiovagal autonomic function tests.

MATERIALS AND METHODS:

SUBJECTS:

Institutional ethic committee clearance was obtained following which, apparently healthy males between the ages 18 and 30 years were included in the study. Since menstrual cycle modulates autonomic nervous system, females were not included in the study (Yildirir et al. 2002). Volunteers for the study were medical students and non-teaching staffs. The medical students did not get any credits points for participating in the study neither the staff any financial compensation. Seventy-eight males were screened and men with deviated nasal septum, nasal polyps, ongoing rhinitis (common cold), diabetes, chronic alcoholism, any other causes of peripheral/autonomic neuropathy and smoking habit as well as regular yoga practitioners were excluded from the study. After exclusion, 68 men participated in the study, out of which 50 of them completed and their data were used for analysis.

PROCEDURE:

All participants reported to the electrophysiological lab, Department of Physiology, from 9 AM till 11 AM. After obtaining written informed consent, their anthropometric parameters were measured. Height was measured to the nearest 0.1 cm and weight to the nearest 0.1kg. BMI was calculated using weight in kg divided by height squared in meters (Quetelet index). Participant's basal battery of autonomic function tests was performed, which included resting heart rate, E:I ratio, Valsalva manoeuvre and 30:15 ratio. They again came to the lab every day for seven consecutive days from 9 to 11 AM and performed supervised left unilateral forced nostril breathing exercise (LUFNB). The same battery of autonomic function tests was performed again on the eighth day between 9Am and 11AM and noted as post-intervention values.

LEFT UNILATERAL FORCED NOSTRIL BREATHING (LUFNB):

Participants were made to sit comfortably on a chair and made to occlude the right nostril using their right thumb. They breathed in and out through the left nostril in a timed manner with five seconds of inhalation and five seconds of exhalation making one cycle, thus comprising of 6 cycles in one minute. The timing was given by the investigator using wristwatch. The participants performed this supervised left unilateral forced nostril (LUFNB) breathing for a period of 2 minutes every day for seven consecutive days.

CARDIOVAGAL AUTONOMIC FUNCTION TESTS:

The cardiovagal autonomic tests were performed on the subjects, who had lite breakfast without coffee or tea, and recorded using Polyrite 4 channel (Ambala, India) with simultaneous ECG and respiratory recording. The leads were connected one on the acromial end of the right clavicle, one on the acromial end of the left clavicle and one on the left iliac crest for minimal movement artefacts. The respiratory belt was fixed at the fourth intercostal space where there is maximal chest movement during breathing. The cardiovagal autonomic function tests were performed on the first visit for baseline reading and on the 8^{th} day after completing the seven-day supervised LUFNB. Participants were given 3 minutes rest in between each of the autonomic function test. Following is the battery of autonomic function test (AFT) tests performed.

RESTING HEART RATE:

The participants were made to lie down supine on the bed and relax for 5 minutes. After 5 minutes rest, lead II ECG was recorded for a period of two minutes. The RR intervals were entered in an excel sheet and the heart rate was calculated. The average heart rate of the two minutes recording was taken as resting heart rate. Resting heart rate reflects the rate of the cardiac vagal firing (Leon et al. 1970).

E:I RATIO FOR TIMED DEEP BREATHING (TDB):

The participants were made to breath slow and deep in a periodic manner with 5 seconds of inspiration and 5 seconds of expiration, thus breathing at the rate of 6 cycles per minute (0.1 Hz). The pacing for breathing was given externally using verbal commands and simultaneous ECG was recorded. ECG paper was manually marked for inspiration and expiration based on the respiratory reading. The E:I ratio was calculated by dividing the longest RR interval during expiration by the shortest RR interval during inspiration in each 10 seconds cycle. Six such E:I ratios were calculated, and the average was noted. This test reflects the functionality of cardiovagal fiber oscillation.

VALSALVA MANOEUVRE :

To perform the Valsalva manoeuvre, a 40-mmHg pressure must be generated from the thorax and maintained for 15 seconds. For this purpose, a 5-cc syringe (plunger removed) with a hole was attached to a manometer and participants blew into it to maintain 40 mmHg for 15 seconds. The syringe with the hole is a pressure leak system to prevents the pressure being generated from the mouth instead from the thorax. ECG was recorded during the manoeuvre and 30 seconds thereafter. There are four phases in this manoeuvre. The first two during the manoeuvre and the last two after the manoeuvre. The ratio between the longest RR interval during phase IV (around the 30 second period after the manoeuvre) and shortest RR interval during phase II (last half during the manoeuvre) is called Valsalva ratio. This test is reliable to documents the intactness of sympathovagal function (Ewing et al. 1973).

30:15 RATIO (HEART RATE RESPONSE TO STANDING):

After three minutes rest in the supine position, participants were asked to stand and remain standing for 2 minutes. During this procedure continuous ECG was recorded and the time of standing was noted on the ECG paper. The ratio between the longest RR interval around the 30^{th} beat and the shortest RR interval around 15^{th} beat after standing up is noted as 30:15 ratio. This reflects the sympathovagal function.

STATISTICAL ANALYSIS:

Data were examined for normal distribution using the Shapiro Wilk test and the visual histogram plot. Descriptive statistics are expressed as mean and standard deviation as well as range distribution. To elucidate the effect of breathing exercise on the cardiovagal autonomic parameters, paired "t" test was performed on normally distributed data and Wilcoxon signed ranks test was performed on non-parametric data. The statistical significance was kept at $p < 0.05$. The statistical analysis was performed using SPSS version 21.

RESULTS:

The descriptive data of the study group is given in table 1. The BMI of the participants ranged from 17.7 to 36.8. The age range of the participants were from 18 to 30 years. Table 2 depicts the comparison of the battery of autonomic tests performed before and after LUFNB for one week. Since the data were normally distributed among the resting heart rate and Valsalva ratio, paired "t" test was performed to analyze the statistical significance. The resting heart rate reduced from the mean 72 beat per minute to 70 beats per minute which was statistically significant (<0.001). Similarly, there was a significant increase in the Valsalva value (1.60±0.11 Vs 1.64±0.13; p<0.001). To find the significance of change in E:I ratio and 30:15 ration Wilcoxon signed ranks test was performed since the data was not normally distributed. The median values of E:I ration improved from 1.43 to 1.47 and 30:15 ratio improved from 1.47 to 1.53 which were statistically significant (p<0.001).

Table 1 : Descriptive data of the study group (n=50)

Parameters	Mean	Standard Deviation (SD)	Range
Age (years)	22	3	18 - 30
Height (meters)	1.71	0.06	1.61 - 1.85
Weight (kilograms)	72.1	13.0	46 - 105
BMI (kg/m2)	24.56	3.73	17.7 - 36.8

Table 2 : Comparison of cardiovagal autonomic function test values between baseline and after left unilateral forced nostril breathing (LUFNB) for one week

Parameters	Baseline value	Post-intervention values	P value
Baseline Heart Rate (BPM)*	72±7	70±7	< 0.001*
E:I Ratio due to Timed Deep Breathing#	1.43 (1.39-1.51)	1.47 (1.40-1.55)	< 0.001#
Valsalva Ratio*	1.60±0.11	1.64±0.13	< 0.001*
30:15 Ratio due to standing#	1.47 (1.37-1.55)	1.53 (1.44-1.60)	< 0.001#

*Data expressed as mean ± standard deviation, P value obtained from paired "t" test. #Data expressed as median and interquartile range; P value obtained from Wilcoxon signed ranks test

DISCUSSION:

We have demonstrated that one week of 2 minutes left unilateral forced nostril breathing (LUFNB) can enhance cardio vagal activity. Our study suggests that by altering the nasal cycle (LUFNB), it is possible to influence the activity of the contralateral cerebral hemisphere which agrees with recent study using infrared spectroscopy (Singh et al. 2016). Further, our study demonstrates that the residual effect (lasting for a day after 7 days practice) of the unilateral forced nostril breathing technique on autonomic activity. Hence, we suggest LUFNB practice could act as a functional parasympathetic activator and thus affecting many physiological parameters like hear rate and blood pressure.

It is evident that slow breathing at 6 cycles/min (at the rate of 0.1 Hz) will accentuates respiratory sinus arrhythmia (RSA) which is vagally mediated (Kuo and Chen 1998), though its magnitude is also modulated by the prevailing sympathetic tone (Taylor et al. 2001). This enhancement in RSA is due to the synchronization of the respiratory-induced and baroreflex-induced RR low frequency interval oscillations (Bernardi et al. 2001). Slow deep breathing yoga practices like "Bhastrika Pranayama" alone can enhance vagal tone (Pramanik et al. 2009). Our breathing practice was also maintained at 0.1 Hz, albeit, through left nostril alone (unilateral) and it can be speculated that this slow-paced breathing by itself could have contributed for our observed results. However, more recent studies have demonstrated that yogic breathing techniques through unilateral nostril have a profound effect on physiological parameters like heart rate and blood pressure. It suggests that right nostril breathing stimulate activity state (sympathetic) and left nostril stimulates the resting state (parasympathetic) in the basic rest activity cycle (A. B. Bhavanani et al. 2014). Similarly, our results show that LUFNB technique increases the vagal tone as reflected by all the measured cardiovagal autonomic parameters. The resting heart rate of our participants, which is predominately a function of vagal tone, reduced due to the LUFNB for one week. Similarly, in a study where the LUFNB practiced for 27 rounds, which is called in yogic sciences as "Chandra Nadi Pranayama", demonstrated an immediate fall in heart rate, systolic blood pressure, pulse pressure in essential hypertensive participants (A. B. Bhavanani et al. 2012). The E:I ratio due to TDB improved significantly in our study, which reflects the gain in parasympathetic oscillation. To the best of our knowledge this is the first study to find the direct effect of LUFNB on E:I ratio. E:I ratio was found to be increased in Raja Yoga meditators compared to normal people (Bharshankar et al. 2015). The Valsalva manoeuvre is a better indicator of the vagal baroreflex sensitivity (Pstras et al. 2016; Wada et al. 2014). The Valsalva ration also improved in our study participants due to LUFNB. An earlier study showed no change in Valsalva ration among medical students due to slow breathing practice for three months (Pal et al. 2004). The heart rate changes due to active standing, as measured by 30:15 ratio, also improved in the present study. Heart rate changes to standing reflect the vagal activity although the sympathetic nervous system plays a modulatory role in the manoeuvre. To our knowledge only one study showed improvement in 30:15 ration among the Raja Yoga meditators compared to normal people (Bharshankar et al. 2015).

Diabetic autonomic neuropathy (DAN) is a common complication of long duration diabetes with the tests of the parasympathetic function affecting first followed by the sympathetic (Ewing et al. 1980). The prognosis is poor when there is positive abnormal autonomic test with resting tachycardia and postural hypotension in diabetics. Therefore, along with the medical management, our technique of LUFNB can be explored as an adjuvant therapy to prevent DAN. The first clinical study to demonstrate breathing practices like "awareness breathing" coupled with "alternate nostril slow breathing" can reduce anginal pain was performed in 1958 (Friedell 1958). These patients were eventually able to curtain their niroglycerine. Later, a randomized control study demonstrated that yoga asanas with right nostril breathing (Surya Nadi pranayama) practices had beneficial effects in irritable bowel syndrome (Taneja et al. 2004). One of the preliminary scientific report with 10 participants demonstrated that TDB (6 cycles per minute) could attenuate the occurrence of premature ventricular complexes by around 50% by enhancing vagal tone (Prakash et al. 2006). Increased physical activity and cardiorespiratory fitness reduces the risks of cardiovascular disorders and this is mediated through enhanced autonomic nervous system (Oliveira et al. 2018). Therefore, autonomic nervous system plays a pivotal role in health and disease. Hence, large randomized control trials showed be performed to evaluate the effectiveness of this ancient non-invasive breathing technique to enhance the activity of the autonomic nervous system.

LIMITATION OF THE STUDY:

We were unable to demonstrate the underlying physiology of the influence of LUFNB on parasympathetic nervous system which was beyond the scope of our study. We did not check for the handedness of the participants using any validated method (Searleman et al. 2005). Also there were no control group to rule out the Howthorne effect.

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