Immediate Effect of Alternate Nostril Breathing On Cardiovascular Parameters and Reaction Time

Ananda Balayogi Bhavanani[a], Meena Ramanathan[b], Madanmohan[c]
[a]Deputy Director, CYTER, MGMCRI, Pillayarkuppam, Pondicherry 607402, India
[b]Co-ordinator and Yoga therapist, CYTER, MGMCRI, Pondicherry, India
[c]Professor and Head, Department of Physiology and Director CYTER, MGMCRI, Pondicherry, India

Corresponding author:
Ananda Balayogi Bhavanani
Deputy Director, CYTER, MGMCRI, Pillayarkuppam, Pondicherry 607402, India

Abstract

Background: This study evaluated immediate effects of 27 rounds of left nostril initiated alternate nostril breathing (ANB) technique of nadi shuddi (NS) and right nostril initiated ANB of aloma viloma (AV) pranayama on cardiovascular (CV) parameters and reaction time (RT) in a trained population.

Materials and methods: 16 subjects attending regular yoga sessions were recruited and each subject performed 27 rounds of either technique, selected randomly on different days. Heart rate (HR), systolic pressure (SP), diastolic pressure (DP), auditory and visual reaction time (ART and VRT) were recorded before and after pranayamas. NS was done by breathing in through left nostril and out through right followed by breathing in through right and out through left. AV was done by breathing in through right nostril and out through left followed by breathing in through left and out through right. All data passed normality testing and statistical analysis was carried out using Student's paired t test.

Results: HR, SP and DP reduced significantly ($p < 0.05$ to 0.001) after NS while they increased after AV. Post intervention differences as well as Δ% between groups was significant ($p < 0.05$ to 0.001) for HR, SP and DP. ART and VRT were significantly ($p < 0.05$ to 0.001) shortened after AV and significantly prolonged after NS. Post intervention differences as well as Δ% between groups was very significant ($p < 0.001$) for both ART and VRT.

Discussion: Significant reductions of HR, SP and DP after NS and their increase after AV may be attributed to modulation of autonomic tone. Right nostril initiated ANB technique produces autonomic arousal, whereas left nostril initiated ANB technique induces relaxation/balance. These can be selectively applied in various therapeutic settings. Further studies in various clinical conditions and settings can enable us to understand their therapeutic applications better.

KEYWORDS: *alternate nostril breathing, pranayama, reaction time, yoga*

INTRODUCTION:

Shiva Swarodaya, a classical yogic text describes the ultradian nasal cycle as *Swarodaya Vigyan* and highlights differential effects of its phases that reflect the lunar cycles [(1)] Yogic teachings reiterate that breathing exclusively through the left nostril potentiates *ida nadi*, the "lunar channel" while breathing exclusively through the right activates *pingala nadi*, the "solar channel".

In the past few decades scientific studies on uni-nostril breathing (UNB) and alternate nostril breathing (ANB) have reported physiological and psychological effects of *pranayama* techniques such as right UNB (*surya nadi*), left UNB (*chandra nadi*), right initiated ANB (*surya bhedana*), left initiated ANB (*chandra bhedana*) and *nadi shuddhi* (NS). [2, 3, 4, 5, 6] Performance of ANB has been reported to rapidly alter cardiopulmonary responses and improve simple problem solving [7] and a tilt toward parasympathetic dominance has been demonstrated after even just 15 min of ANB involving two breath cycles for each round of the practice.[5]

It is important to scientifically validate specific differential effects of various ANB techniques and to the best of our knowledge no study has compared NS and aloma viloma (AV) pranayama. Both of them are 'two breath cycle' ANB techniques, but the breathing is initiated through left nostril in NS (left in-right out-right in-left out) while it is initiated through right nostril in AV (right in-left out-left in-right out).

With the above in mind, this study planned to evaluate immediate effects of 27 rounds of NS and AV on cardiovascular (CV) parameters and reaction time (RT) in a trained population. For CV parameters we selected heart rate (HR) as well as systolic pressure (SP) and diastolic pressure (DP) as these indicate changes in cardiac autonomic regulation while for RT that is an index of processing ability of central nervous system and a simple, non invasive means of determining sensorimotor co-ordination and performance we selected auditory and visual RT (ART and VRT respectively). [8, 9]

MATERIALS AND METHODS:

Sixteen subjects (11 females, 5 males) attending regular yoga sessions at the Centre for Yoga Therapy, Education, and Research (CYTER) twice / thrice weekly for more than 2 months were recruited for this self-controlled study by convenience sampling. Their mean age was 31.06 ± 8.96 (SD) years and all were right handed. Three reported normal health status, whereas others reported that they were on regular treatment for one or more medical conditions like hypertension (2), type 2 diabetes mellitus (1), arthritis (1), bronchial asthma (1), poly cystic ovarian disorder (6) and stress (2). None were receiving autonomic modifying agents like α- or β blockers.

Each subject came to the CYTER lab on two different days. They were instructed to have a light breakfast before 8 am and report for the study between 10 am and 12 noon. On each of the days, they performed 27 rounds of either technique, selected randomly so as to avoid any bias or influence of the different days of recording.

The subjects were instructed to sit in any comfortable posture and relax for 5 min before taking pre-intervention recordings of HR, SP, DP, ART and VRT. They then performed the selected technique and all parameters were recorded immediately after performance of 27 rounds. The entire sequence of recording was randomised to avoid any bias.

Both techniques were performed in an erect sitting posture using a hand gesture (*nasika mudra*) wherein ring finger of the right hand was used to occlude left nostril by pressing on the outside of the nostril and the thumb to occlude right nostril as required. The left hand was held in *jnana mudra* and placed on the left thigh in both techniques. The alternate nostril breathing sequence for one round of the technique was as follows:

- NS was done by breathing in through left nostril and out through right followed by breathing in through right and out through left.
- AV was done by breathing in through right nostril and out through left followed by breathing in through left and out through right.

Participants were instructed to focus their mind on their breath and ensure it was slow, deep, and regular while attempting to utilize all sections of their lungs. Respiratory rate for both techniques was maintained at approximately 5-6 breaths per min (BPM) and this was regulated by one of the investigators providing an audible count of six for both inspiration and expiration. As they were all attending regular yoga sessions, none reported any difficulty in performing 27 rounds of the techniques as given above.

To ensure objectivity in measuring HR and BP, the recordings were done using non-invasive automatic BP monitor (HEM– 7203, Omron Healthcare Co. Ltd, Kyoto, Japan) with an instrumental accuracy of ±5% for HR and ±3 mm Hg for BP. RT apparatus (Anand Agencies, Pune) with a built in 4 digit chronoscope and display accuracy of 1 ms was used for the study. Auditory beep sound stimulus was used for ART and red light stimulus for VRT. The subjects were instructed to release the response key as soon as they perceived the stimulus. Signals were given from the front to avoid effect of lateralized stimulus and they used dominant hand while responding to signals.[3, 4] All subjects were given adequate exposure to the equipment on two different occasions to familiarize them with the procedure as RT is more consistent when subjects have had adequate practice. [6] More than ten trials were recorded and the mean of three similar observations was taken as a single value for purpose of statistical analysis. [10, 11]

Data were assessed for normality using GraphPad InStat version 3.06 for Windows 95, (GraphPad Software, San Diego California USA). All data passed normality testing by Kolmogorov-Smirnov Test and hence intra and inter group analysis was carried out using Student's paired t test.

RESULTS:

The results are given in Table 1. HR, SP and DP reduced significantly ($p < 0.05$ to 0.001) after NS while they increased after AV. The post intervention differences as well as Δ% between groups was significant ($p < 0.05$ to 0.001) for HR, SP and DP.

ART and VRT were significantly ($p < 0.05$ to 0.001) shortened after AV and significantly prolonged after NS. The post intervention differences as well as Δ% between groups was very significant ($p < 0.001$) for both ART and VRT.

DISCUSSION:

The significant reductions of HR, SP and DP after NS and their increase after AV may be attributed to modulation of the resting autonomic tone. Previous reports support our finding that right nostril initiated UNB and ANB techniques induce a state of arousal through sympathetic activation and / through increased ascending reticular activity and / by central action at the primary thalamo-cortical level. [4, 6, 12, 13] This autonomic arousal may also explain faster reactivity seen after AV and signifies an enhancement of central neuronal processing ability. This may be due to a faster rate of information processing as well as improved concentration that enables selective

inhibition of extraneous stimuli. The slower reactivity after NS on the other hand, may be attributed to the induction of a more relaxed state of parasympathetic dominance in our subjects, as evidenced by reductions in all CV parameters. [13]

Some researchers have tried to explain the differential physiological and psychological changes due to right and left nostril breathing and have postulated various mechanisms. Shannahoff-Khalsa suggested that mechanical receptors in the nasal mucosa register flow of air across membranes (unilaterally) and transmit this signal ipsilaterally to the hypothalamus, the highest center for autonomic regulation.[2] He also suggested that right nostril dominance in the nasal cycle as well as right UNB may be correlated with the "activity phase" of the basic rest-activity cycle, the time during which sympathetic activity in general exceeds parasympathetic activity throughout the body.[2] Differences between right and left vagus nerves have been reported with right vagus having greater cardiac deceleratory effect compared to left and right vagus exerting greater restraint on SA node than left.[2] Another study suggested that ultradian rhythms of HR may be also governed by alternating rhythmic influences of the right and left branches of the autonomic nervous system with increased HR resulting from right sympathetic with left parasympathetic dominance.[12] Kennedy reported alternating left–right levels of catecholamines in peripheral circulation of resting humans with rhythms coupled to the nasal cycle.[14]

As the present study provides more supporting evidence to these earlier reports, we can plausibly conclude that right nostril initiated ANB techniques produce autonomic arousal, whereas left nostril initiated ANB techniques induce autonomic relaxation/balance. These techniques can be selectively applied in various therapeutic settings with NS benefiting those who require relaxation, reduction of stress, anxiety and hypertension while AV can be applied in patients of depression, narcolepsy and learning disorders. Further studies in various clinical conditions and settings can enable us to understand their therapeutic applications better.

ACKNOWLEDGMENTS:

The authors thank the management of Sri Balaji Vidyapeeth University for setting up and supporting the Centre for Yoga Therapy, Education and Research (CYTER) in Mahatma Gandhi Medical College and Research Institute (MGMCRI). We are grateful to Yogacharini Meenakshi Devi Bhavanani, Director ICYER for her constant motivation and supportive guidance. Thanks are due to D Pushpa, G Sarulatha and M Sangeeta for their valuable assistance during training, recording sessions and data entry. We thank all the subjects for their wholehearted cooperation during the training and recording sessions.

REFERENCES:

1. Bhavanani AB, Swarodaya Vigjnan- A Scientific Study of the Nasal Cycle. Yoga Mimamsa 2007; 39 : 32-8.
2. Shannahoff-Khalsa DS. Unilateral forced nostril breathing: Basic science, clinical trials, and selected advanced techniques. Subtle Energies and Energy Med J 2002; 12: 79-106.
3. Mohan SM. Svara (Nostril dominance) and bilateral volar GSR. Indian J Physiol Pharmacol 1996; 40: 58–64.

4. Raghuraj P, Telles S. Immediate effect of specific nostril manipulating yoga breathing practices on autonomic and respiratory variables. Appl Psychophysiol Biofeedback 2008; 33: 65–75.
5. Srivastava RD, Jain N, Singhal A. Influence of alternate nostril breathing on cardiorespiratory and autonomic functions in healthy young adults. Indian J Physiol Pharmacol 2005;49:475-83.
6. Telles S, Nagaratna R, Nagendra HR. Breathing through a particular nostril can alter metabolism and autonomic activities. Indian J Physiol Pharmacol 1994; 38: 133–7.
7. Subbalakshmi NK, Saxena SK, Urmimala, D'Souza UJ. Immediate effect of 'Nadi-shodhana Pranayama' on selected parameters of cardiovascular, pulmonary, and higher functions of brain. Thai J Physiol Sci 2005;18:10-6.
8. Lofthus GK. Sensory motor performance and limb preference. Percepts Motor Skills 1981; 52: 688-93.
9. Das S, Gandhi A, Mondal S. Effect of Premenstrual stress on Audiovisual reaction time and audiogram. Ind J Physio Pharmacol 1997; 41: 67-70.
10. Madanmohan, Thombre DP, Balakumar B, Nambinarayanan TK, Thakur S, Krishnamurthy N, et al. Effect of yoga training on reaction time, respiratory endurance and muscle strength. Indian J Physiol Pharmacol 1992; 36: 229–33.
11. Bhavanani AB, Ramanathan M, Harichandrakumar KT. Immediate effect of mukha bhastrika (a bellows type pranayama) on reaction time in mentally challenged adolescents. Indian J Physiol Pharmacol 2012; 56: 174-80.
12. Shannahoff-Khalsa DS, Kennedy B. The effects of unilateral forced nostril breathing on the heart. Int J Neurosci 1993; 73: 47-60.
13. Bhavanani AB, Ramanathan M, Balaji R, Pushpa D. Differential effects of uninostril and alternate nostril pranayamas on cardiovascular parameters and reaction time. Int J Yoga 2014; 7: 60-65.
14. Kennedy B, Ziegler MG, Shannahoff-Khalsa DS. Alternating lateralization of plasma catecholamines and nasal patency in humans. Life Sci 1986; 38: 1203-14.

Table 1: Immediate effect of nadi shuddi and aloma viloma pranayamas on heart rate (HR), systolic pressure (SP), diastolic pressure (DP), auditory reaction time (ART) and visual reaction time (VRT) in the same subjects before (B) and immediately after (A) performance of 27 rounds of the respective technique.

	Nadi shuddi Pranayama			Aloma viloma Pranayama			Comparison (p value)		
	B	**A**	**Δ%**	**B**	**A**	**Δ%**	**B**	**A**	**Δ%**
HR (beats/min)	86.67 ± 9.41	78.67 ± 7.31 ***	-8.89 ±4.89	82.69 ±10.36	85.77 ± 12.16	3.72 ±7.36	0.13	0.032	<0.001
SP (mmHg)	119.42 ±11.24	113.58 ±10.44***	-4.76 ±3.76	117.17 ±11.27	120.16 ±8.91*	2.82 ±4.45	0.07	<0.001	<0.001
DP (mmHg)	74.92 ± 8.15	73.00 ± 5.05*	-1.98 ±4.74	75.67 ±7.05	79.76 ±7.26***	5.55 ±5.28	0.66	<0.001	<0.001
ART (msec)	193.75 ±16.44	204.08 ±14.86***	5.51 ±3.12	190.35 ±18.79	178.65 ±19.26***	-6.17 ±3.15	0.50	<0.001	<0.001
VRT (msec)	213.68 ±16.44	221.75 ± 15.46 **	3.94 ±3.87	211.31 ±17.83	203.69 ± 18.08**	-3.51 ±4.82	0.64	0.002	<0.001

Values are given as mean ± SD for 16 subjects. * $p < 0.05$, ** $p < 0.01$ and *** $p < 0.001$ by paired t test for intra group comparisons. Actual p values are given for paired t test for intergroup comparisons. Δ % comparisons were done by paired t test.