JOY: The Journal of Yoga

Acute Effect of Unilateral and Bilateral Nostril Breathing on Sympathovagal Balance in Yoga Practitioners and Healthy Volunteers

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Abstract:

Objective: To study the effect of single nostril breathing, deep breathing on the heart rate, blood pressure and frequency domain parameters of heart rate variability in yoga practitioners (pranayama) and healthy male volunteers.

Background: Short-term heart rate variability (HRV) is used as an index of autonomic function. HRV is influenced even by one single deep breath. Ancient Sanskrit literature describes the continuous shifting of autonomic balance between the two body halves as represented by rhythmic alterations of airflow through the 2 nostrils. Studies have shown that sympathetic activity increases immediately after normal as well as deep breathing through right nostril and parasympathetic activity increases with left nostril breathing.

Method: Study was conducted in Autonomic lab, Department of Physiology, JIPMER, Puducherry, India. Healthy volunteers in the age group of 18-20 were included in group 1and the volunteers practicing yoga for 2 months were included in group 2. Subjects were asked to perform the following procedure: breathing at comfortable rate with both nostril, left nostril and right nostril, deep breathing with both nostrils, left nostril and right nostril at the rate of 6 breaths per min. All the procedure was done in supine position and 5 min ECG was recorded immediately after each procedure with the breathing at a comfortable rate involuntarily with both nostrils. HRV was analyzed using HRV software version 1.1, Kupio University, Finland.

Result: Deep breathing in all 3 methods increases the HRV both in control and yoga group. Deep breathing through both the nostrils increased parasympathetic activity (HRV) in both the groups.Left nostril breathing increased parasympathetic activity and decreased sympathetic activity and the right nostril breathing increased sympathetic activity and decreased parasympathetic activity in both the groups. The finding was observed in both the groups but it was more pronounced in yoga group.

Conclusion: Regular practice of yoga (pranayama) enhances the lateralizing effect of autonomic function.

Keywords: Yoga, HRV, unilateral nostril breathing, sympathovagal balance

Introduction:

The balance between sympathetic and parasympathetic limbs of autonomic nervous system is essential for maintaining the milieu interior. The physiological state of the body determines the dominance of either of the limbs over the other. Short-term heart rate variability (HRV) is used as an index of autonomic function (1). HRV is influenced by various factors, the most important being respiration. Studies have been done to demonstrate the influence of respiration at various rates and depths on HRV (2;3). Even one single deep breath can modulate HRV (4). Ancient Sanskrit literature describes the continuous shifting of autonomic balance between two body halves as represented by rhythmic alterations of airflow through the two nostrils (5). Recently, it has been suggested that there might be nostril laterality affecting the autonomous nervous system differentially (2). Studies have shown that sympathetic activity increases immediately after normal as well as forced/deep breathing through right nostril(5;6). However, there is paucity of literature on the acute effect of unilateral nostril breathing on sympathovagalbalance. Therefore we planned to study the effect of normal and deep breathing through both, right and left nostril on short term HRV in normal human healthy volunteers and in subjects who have been practicing yoga (Pranayama) for 2 months.

Materials and methods:

The tests were performed at Autonomic Lab, Department of Physiology, JIPMER, India. Study was approved by JIPMER scientific advisory committee and JIPMER Ethics committee for Human studies. Written informed consent was obtained from all the participants.

Subjects: Subjects were healthy male volunteers in the age group of 18-20.

Group 1: Healthy male volunteers (n=18)

Group 2: Healthy male volunteers practicing yoga for 2 months (n=16). Yoga practice included, Chandra nadi pranayama (left), Surya nadi pranayama (right), Nadishuddhipranayama (both) each for 6 cycles,3 repetitions with 1 minute interval for 5 days a week for 2 months.

Protocol: Subjects were instructed, not to consume coffee, tea or any other stimulant or engage in any strenuous physical activity for at least 4 hours before reporting to the laboratory. After familiarizing them with the laboratory environment and after 10-15 minutes rest, Lead II ECG and respiration were recorded using Biopac MP 100 system and 3.7.3 Acqknowledge software for five minutes. The recordings were taken immediately after each maneuver with the subjects lying supine comfortably on the couch

- Breathing at comfortable rate through
  a. Both nostrils
  b. Right nostril while left nostril was closed by cotton plug
  c. Left nostril while right nostril was closed by cotton plug

- Deep breathing at the rate of 6 breaths per min through
  a. Both nostrils
  b. Right nostril while left nostril was closed by cotton plug
  c. Left nostril while right nostril was closed by cotton plug

After recording ECG for 5 minutes, heart rate (HR) and blood pressure (BP) were measured with a non-invasive automated blood pressure monitor (Press-mate BP8800, Colin Corporation, Japan). Rest was given for five minutes after eachrecording. ECG was acquired at a rate of 500 samples per second. After resampling RR intervals (300 seconds) and editing ectopic, noise and artifacts, the trend in variation in HR around basal HR due to the interaction between sympathetic and parasympathetic activity were analyzed using HRV software (version 1.1., Biomedical signal analysis group, University of Kuopio, Finland) by fast Fourier Transformation (7). Frequency spectral components classified based on the range of area under the power spectrum as low frequency power (LF) betweem 0.025 to 0.15 Hz represents contribution from parasympathetic and sympathetic systems, high frequency power (HF) between 0.16 to 0.4 Hz represents contribution from parasympathetic system to cardiovascular system and the ratio of LF/HF represents a measure of the balance of parasympathetic and sympathetic system influenced primarily by parasympathetic nervous system. The normalized units were calculated as LFnu=LF x 100/ (LF+HF) and HFnu= HF x 100/ (LF+HF).

Statistical analysis:

The parameters were compared using repeated measures ANOVA (post hoc) for intra group comparisons and unpaired t test (parametric) and Mann- Whitney test (non-parametric)for inter group comparisons. $P < 0.05$ was taken as statistically significant.

Results&Discussion:

Deep breathing through both nostril reduced/improved the HR and BP in both yoga and control group. The fall/improvement was more pronounced in yoga group represented in Table 2.

Reduction/improvement in HR may reflect reduction in sympathetic activity or increase in parasympathetic activity. But the reduction in BP should be primarily due to decrease in sympathetic activity as parasympathetic discharge has no direct effect on blood vessels. So it can be clearly stated that deep breathing through both the nostril reduces sympathetic activity but its effects on parasympathetic activity has to be confirmed with HRV findings. Discorillet al., has reported that metronome breathing at the rate of 12 breaths/ minute does not produce any significant change in radial artery BP(3). Author also commented that the depth of breathing was more but the rate was similar to the subject's normal respiratory rate (RR) (3). In our study the deep breathing was done at the rate of 6 breaths/ minute. So reduction observed in HR and BP in our study may be mainly due to the change in the RR rather than the change in depth of breathing.

While breathing at a comfortable rate through both nostril i.e., at rest, HR and BP were less in yoga group as compared to control group. Further it is interesting to note that their resting HR and BP were similar or even lesser as compared to values of control groupdoing deep breathing with both nostrils. The respiratory rate (RR) of the yoga practitioners at rest was less as compared to control group (yoga, 12.38±1.36 and Control, 15.88±2.03). Decreased resting RR may be a possible cause of decrease in resting HR and BP in yoga group but the RR was still above 6 breaths/ minute in all the yoga practitioners.So we can argue that eventhough the RR plays an important role in reducing HR and BP, regular practice of yoga can alter the basic tone of the discharge of autonomic nervous system irrespective of RR.

It has been reported that deep breathing through right and or left unilateral nostril in male subjects increases systolic BP and HR but not diastolic BP (2). In our study we observed a decrease in HR, diastolic BP and systolic BP after left nostril breathing in both deep and comfortable breathing and in both groups. The fall was more after deep breathing (Table 2). So deep breathing increases the lateralization effect of unilateral breathing. Further the fall was more in yoga group as compared to control group. So it can also be concluded that the yoga training accentuates the lateralizing effect of unilateral nostril breathing on autonomic nervous function. Opposite to this, we were able to observe an increase in HR and BP after right nostril breathing. It has been reported that deep breathing is beneficial in heart failure patients where it increases baroreflex sensitivity and causes a significant decrease in diastolic BP(8). With our results we can suggest that the deep breathing with left nostril can give a better result to reduce the BP and to get the best, yoga (breathing practices) to be practiced.

Total power (TP) in frequency domain analysis indicates the overall HRV. TP denotes the decrease in risk for future cardiovascular diseases (9). TP was increased after deep breathing through both nostrils in both the groups. TP was increased in yoga group as compared to control group both after comfortable breathing and deep breathing. HF represents parasympathetic activity while the LF represents predominantly sympathetic activity with small contribution from parasympathetic activity. Eventhough LF which denotes sympathetic activity was observed to rise after deep breathing, it should be noted that the corresponding increase in HF was more, ultimately resulting in decreased LFnu. Hence the basal tone of both sympathetic and parasympathetic are increased which ultimately increases the TP but the parasympathetic activity has a dominant hand over sympathetic activity which gets reflected in LFnu and the same was reflected in decreased HR as stated earlier. LFnu was lesser and HFnu was higher during deep breathing with both nostrils and left nostril as compared to comfortable breathing in both the groups. Further LFnu was found to be increased and HFnu was decreased during right nostril breathing. As we probed deeper into the percentage increase in the HFnu and decrease in LFnu, we were able to note that the there was a trend: Increase/decrease in HRV parameters in yoga group after normal comfortable breathing was more than that observed after deep breathing in control group and the increase/decrease in HRV parameters in yoga group deep breathing was more than that observed after normal breathing. LF/HF ratio was reduced after deep breathing(both nostrils) in both the groups and it was decreased in yoga group as compared to control group.

By considering both the cardiovascular parameters and the HRV parameters it can be deduced that yoga training can reduce sympathetic discharge and increase parasympathetic discharge even at rest and the deep breathing can bring those effects immediately. One of the limitation of this study is that we have not measured the duration for which the effects of deep breathing or unilateral nostril breathing lasts which would give the logical extension to the present study.

Our findings can be attributed to the changes brought about by fluctuations in BP during deep breathing. Left nostril breathing is called as Chandra nadi pranayama which is shown to reduce sympathetic activity and the breathing through right nostril is called as Surya nadi pranayama which is shown to increase sympathetic activityin the ancient literature.There are studies supporting that right nostril breathing is known to have sympathetic stimulating effect(5;6) but there are very few reports regarding left nostril breathing. Our findings were consistent with the long held view. Previous studies showed no significant difference in HF during spontaneous and metronome guided breathing at normal comfortable rate (10;11). In our study the RR was reduced to 6 breaths per minute irrespective of their basal RR. Even after the deep breathing the percentage difference in the LFnu and HFnu was very small in control group but the difference was more for the yoga group (Table 2). This shows the importance of the regular practice of yoga.

There is growing evidence that cerebral laterality controls the autonomic function (12). Right hemispheric inactivation is known to produce a significant decrease in BP and an increase of HF whereas left hemisphere inactivation produces increase HR, BP and LF (1). Left hemispheric inactivation using amobarbital produces a significant increase in LF/HF ratio, indicating that the right cerebral hemisphere predominantly modulates sympathetic activity (13). Unilateral forced nostril breathing is known to differentially activate the two hemispheres and bring about improvement in specific cognitive tasks (14). Forced nostril breathing in through one nostril produces a relative increase in EEG amplitude in the ipsilateral hemisphere and lateralized increase in release of catecholamine (14). Thus, the decrease in diastolic BP during left nostril deep breathing among yoga group can be attributed to activation of left hemisphere and inactivation of right hemisphere that predominantly influences sympathetic activity. During left nostril breathing HF was high in subjects and this indicates a predominant vagal modulation of cardiac activity. These interesting findings need confirmation using a larger sample size. The fact that modification of breathing alters HR, diastolicBP and systolic BP of our yoga group more than the control group suggests that yoga practice has a specific effect on central autonomic modulation.

Earlier studies have shown that the yoga practitioner have lower resting HR and BP due to vagal predominance (15;16). Our findings also are suggestive of sympathetic dominance during rest, among yoga group.

Conclusion:

- Deep breathing increases the TP in HRV.
- The left nostril increases parasympathetic activity and reduces HR and BP, this may be helpful in heart patients.
- Right nostril increases sympathetic activity,
- Lateralization is more pronounced with yoga practice.

Reference List

(1) Hiltz MJ. Differential modulation of autonomic function by brain hemispheres. Annals of neurology 2001;49:575-84.

(2) Dane S, Caliskan E, Karasen M, Oztasan N. Effects of unilateral nostril breathing on blood pressure and heart rate in right-handed healthy subjects. Int J Neurosci 2002 Jan;112(1):97-102.

(3) Driscoll D, Dicicco G. The effects of metronome breathing on the variability of autonomic activity measurements. J Manipulative Physiol Ther 2000 Nov;23(9):610-4.

(4) Cammann H, Michel J. How to avoid misinterpretation of heart rate variability power spectra? Comput Methods Programs Biomed 2002 Apr;68(1):15-23.

(5) Mohan SM, Reddy SC, Wei LY. Modulation of intraocular pressure by unilateral and forced unilateral nostril breathing in young healthy human subjects. Int Ophthalmol 2001;24(6):305-11.

(6) Telles S, Nagarathna R, Nagendra HR. Physiological measures of right nostril breathing. J Altern Complement Med 1996;2(4):479-84.

(7) Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J 1996 Mar;17(3):354-81.

(8) Bernardi L, Porta C, Spicuzza L, Bellwon J, Spadacini G, Frey AW, et al. Slow breathing increases arterial baroreflex sensitivity in patients with chronic heart failure. Circulation 2002 Jan 15;105(2):143-5.

(9) Heart rate variability: standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Circulation 1996 Mar 1;93(5):1043-65.

(10) Bloomfield DM, Magnano A, Bigger JT, Jr., Rivadeneira H, Parides M, Steinman RC. Comparison of spontaneous vs. metronome-guided breathing on assessment of vagal modulation using RR variability. Am J Physiol Heart Circ Physiol 2001 Mar;280(3):H1145-H1150.

(11) Patwardhan AR, Evans JM, Bruce EN, Eckberg DL, Knapp CF. Voluntary control of breathing does not alter vagal modulation of heart rate. J Appl Physiol 1995 Jun;78(6):2087-94.

(12) Tohgi H, Kuroiwa Y, Konno T, Madarame H. Laterality of cerebral controls on somatic and autonomic functions. Tohoku J Exp Med 1990 Aug;161 Suppl:213-29.

(13) Yoon BW, Morillo CA, Cechetto DF, Hachinski V. Cerebral hemispheric lateralization in cardiac autonomic control. Arch Neurol 1997 Jun;54(6):741-4.

(14) Block RA, Arnott DP, Quigley B, Lynch WC. Unilateral nostril breathing influences lateralized cognitive performance. Brain Cogn 1989 Mar;9(2):181-90.

(15) Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med Hypotheses 2006;67(3):566-71.

(16) Bharshankar JR, Bharshankar RN, Deshpande VN, Kaore SB, Gosavi GB. Effect of yoga on cardiovascular system in subjects above 40 years. Indian J Physiol Pharmacol 2003 Apr;47(2):202-6.

Table 1: Comparison between bilateral nostril, left nostril and right nostril breathing during normal and deep breathing maneuvers in control (C) n=18 and yoga (Y) n=16 group

PARAMETERS		NORMAL BREATHING THROUGH			DEEP BREATHING THROUGH		
		Both nostril	Left nostril	Right nostril	Both nostril	Left nostril	Right nostril
HR (beats/min)	C	82.0±11	81.5±13.3	82.5±11.9	81±8.8	83.3±7.3	84.5±7.3
	Y	78.7±8.0	75.3±8.7	82.5±8.9	75.8±8.4	70.2±9$	81.0±8.5
SBP (mmHg)	C	113.6±11.6	113.0±12.9	114.0±9.7	112.4±12.1	111.0±5.7	114.1±12.1
	Y	106.2±6.0$$	100.8±5.7$$$	108.0±9.4$	103±4.5	95.7±11.6$	106.2±5.0
DBP (mmHg)	C	72.8±9.6	72.1±11.5	73.0±11.0	71.6±8.5	70.1±8.2	72.6±8.0
	Y	65.6±3.8	63.8±3.3	67.0±3.4	64.5±5.2	61.3±6.6	67.0±7.5
LF	C	202.0±188	198.0±132.0	210.0±156.0	214.0±114	203.8±111.3	220.0±192.0
	Y	277.3±124.4	255.8±106.5	297.3±104	316.5±145.8	258.7±132.8	386.6±132.7$
HF	C	141.0±151.0	151.0±125.0	128.0±116.0	219.5±178.5	239.0±169.2	191.0±127.0
	Y	236.0±124	266.0±126.0	198.0±146.0	457.0±190.0	529.0±254.0$$$	351.0±178.0€€
LFnu	C	58.89±12.0	56.73±11.8	62.13±12.4	49.37±13.9	46.03±13.3	53.53±14.8
	Y	54.02±14.6	49.02±15	60.02±12.8	40.92±8.0	32.84±9.0	52.41±9.1€€€
HFnu	C	41.11±11.8	43.27±11.9	37.87±12.5	50.63±14.0	53.97±13.3	46.47±14.7
	Y	45.98±14.6	50.98±14.8	39.98±12.8	59.08±8.0	67.16±9.1	47.59±9.1€€€
LF/HF	C	1.43±0.8	1.31±1.2	1.64±1.4	0.97±0.5	0.85±0.4	1.15±0.8
	Y	1.18±0.6	0.96±0.9	1.50±1.2	0.69±0.6	0.49±0.8$$	1.10±1€€
Total Power	C	393.0±201.0	394.0±154.0	394.0±160.1	508.5±186.5	522.8±182.2	485.0±190.2
	Y	613.3±146.0	634.8±150.2	607.3±141.3	899.5±206.1	912.7±220.3	867.6±208.0

*Comparison between both nostril and left nostril , ₣ Comparison between both nostril and right nostril, € Comparison between left nostril and right nostril , # Comparison between normal breathing and deep breathing, $ Comparison between yoga and control group, *,€,$,#,₣: p<0.05 **,$$,₣₣,##,€€: p<0.01 ***,$$$,###, €€€,₣₣₣: p<0.001

Table 2: percentage increase or decrease in cardiovascular parameters and HRV parameters in unilateral breathing as compared to bilateral nostril in each group

PARAMETERS		**NORMAL BREATHING THROUGH**			**DEEP BREATHING THROUGH**		
		Both nostril (exact values)	**Left nostril**	**Right nostril**	**Both nostril***	**Left nostril**	**Right nostril**
HR (beats/min)	C	82.0±11	-0.61	0.61	-1.22	2.84	4.32
	Y	78.7±8.0	-4.32	4.83	-3.68	-7.39	6.86
SBP (mmHg)	C	113.6±11.6	-0.53	0.35	-1.06	-1.25	1.51
	Y	106.2±6.0$^{\$\$}$	-5.08	1.69	-3.01	-7.09	3.11
DBP (mmHg)	C	72.8±9.6	-0.96	0.27	-1.65	-2.09	1.40
	Y	65.6±3.8	-2.74	2.13	-1.68	-4.96	3.88
LF	C	202.0±188	-1.98	3.96	5.94	-4.77	2.80
	Y	277.3±124.4	-7.75	7.21	14.14	-18.26	22.15
HF	C	141.0±151.0	7.09	-9.22	55.67	8.88	-12.98
	Y	236.0±124	12.71	-16.10	93.64	15.75	-23.19
LFnu	C	58.89±12.0	-3.67	5.50	-16.18	-6.77	8.43
	Y	54.02±14.6	-9.26	11.11	-24.26	-19.74	28.09
HFnu	C	41.11±11.8	5.25	-7.88	23.17	6.60	-8.22
	Y	45.98±14.6	10.88	-13.05	28.50	13.67	-19.46
LF/HF	C	1.43±0.8	-8.47	14.52	-31.95	-12.54	18.14
	Y	1.18±0.6	-18.16	27.79	-41.06	-29.39	59.04
Total Power	C	393.0±201.0	0.25	0.25	29.39	2.81	-4.62
	Y	613.3±146.0	3.51	-0.98	46.67	1.47	-3.55

*As compared to normal bilateral nostril breathing