

Physiological Measures of Right Nostril Breathing

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Abstract : This study was conducted to assess the physiological effects of a yoga breathing practice that involves breathing exclusively through the right nostril. This practice is called surya anuloma viloma pranayama (SAV). Twelve volunteers (average age 27.2 years \pm 3.3 years, four males) were assessed before and after test sessions conducted on two consecutive days. On one day the test session involved practicing SAV pranayama for 45 minutes (SAV session). During the test period of the other day, subjects were asked to breathe normally for 45 minutes (NB session). For half the patients (randomly chosen) the SAV session was on the first day and the NB session on the next day. For the remaining six patients, the order of the two sessions was reversed. After the SAV session (but not after the NB) there was a significant ($P < .05$, paired t test) increase in oxygen consumption (17%) and in systolic blood pressure (mean increase 9.4mm Hg) and a significant decrease in digit pulse volume (45.7%). The latter two changes are interpreted to be the result of increased cutaneous vasoconstriction. After both SAV and NB sessions, there was a significant decrease in skin resistance (two factor ANOVA, Tukey test). These findings show that SAV has a sympathetic stimulating effect. This technique and other variations of unilateral forced nostril breathing deserve further study regarding therapeutic merits in a wide range of disorders.

INTRODUCTION

The nasal cycle is an ultradian rhythm with a periodicity of about two to eight hours, during which the right and left nares are alternately patent (Keuning, 1968). Forced right nostril breathing occluding the left nostril was found to increase blood glucose levels (Backon, 1988) and heart rate (Shannahoff-Khalsa & Kennedy, 1993). In a detailed review (Shannahoff-Khalsa, 1991) a number of other physiological and psychological effects of right nostril breathing were suggested, such as generalized sympathetic tonus, increased temperature and metabolic rate, and improved verbal performance. Left nostril breathing had reverse effects. Based on this, the right nostril dominant stage was correlated with the activity phase of the basic rest-activity cycle (BRAC) and with an increase in the sympathetic tone (Wertz, Bickford, Bloom & Shannahoff-Khalsa, 1983). The left nostril dominant stage was correlated with the resting phase of the BRAC and with parasympathetic dominance.

Some varieties of yoga breathing (pranayama) involve inhalation and exhalation through one nostril exclusively. These yoga practices provide an opportunity to study the effects of selective nostril breathing for prolonged periods. Some of the physiological effects of a month of right nostril breathing pranayama (surya anuloma viloma or SAV), practised for ten minutes four times in a day, were found to be significantly different from the effects of a left nostril breathing pranayama (chandra anuloma viloma or CAV) and an alternate nostril breathing pranayama (nadisuddhi or NDS), when all three techniques were practiced for the same frequency and duration (Telles, Nagarathna Nagendra, 1994). SAV caused a significant increase in oxygen consumption (37%), whereas both left and alternate nostril breathing caused a nonsignificant increase in oxygen consumption (24% and 19%, respectively). With all three practices there was a significant decrease in body weight. This reduction was comparable for SAV and CAV (2.3 kg) and less for NDS (1.5 kg). With CAV alone there was a significant decrease in volar skin resistance, interpreted as a reduction in sympathetic tone. While both SAV and CAV were accompanied by a reduction in body weight, SAV alone significantly increased the oxygen consumption. The increase in OC (albeit not significant) following CAV could mean that CAV practice is not actually "cooling" as described by the ancient yoga texts, but more accurately less stimulating than SAV. Of course, the increase in skin resistance following CAV practice shows that this practice does reduce sympathetic activity at least in some divisions of innervation.

The comparable reduction in body weight with both SAV and CAV suggests a possible therapeutic application in obesity for both these practices. However, the maximum increase in oxygen consumption following SAV makes this practice preferable to CAV, particularly in view of the fact that the resting metabolic rate (RMR) in kcal/kg/hour is lower in the obese and is

negatively correlated with the body mass index (BMI) (Dudani, Bijlani, Gupta, Manoch & Nayar, 1986).

Obesity is well known to be associated with a variety of diseases, particularly hypertension and coronary heart disease (Mayer, 1980). Hence, the present study was designed to assess the immediate effects of 45 minutes of SAV pranayama on blood pressure (BP), digit pulse volume, heart rate, breath rate, skin resistance, and oxygen consumption. This information was considered necessary to understand any possible therapeutic merits (and limitations) of this breathing technique.

MATERIAL AND METHODS

Subjects

Twelve volunteers, (four males), age range 21 to 33 years (age mean (SD), 27.2 (3.3) years) participated in the study. None had a history of major illnesses, and on a routine medical examination they were all found to be of normal health. All twelve subjects resided for approximately three months prior to testing at the place where the tests were held. This allowed their diet and schedule (e.g., meal times and time of waking up or sleeping) to be kept constant on the day before testing and on the two days of assessment. The subjects had all been practicing different yoga techniques (asanas and pranayamas, excluding SAV) for approximately ninety minutes every day, during the three months prior to the study. The subjects did not practice the yoga techniques during the days of the study in order to reduce the chance of the short-term effects of these practices modifying the effects of the pranayama practice (i.e., SAV) that was studied.

Design of the study : Assessments were made on two separate days as soon as the subjects woke up in the morning, between 4:15 AM and 5:30 AM. Assessments were taken, followed by the test period (45 minutes), at the end of which assessments were repeated. On day one the test period involved practicing surya anuloma viloma pranayama (SAV) for 45 minutes. This involves breathing exclusively through the right nostril. On day 2, during the 45-minute test period, subjects were asked to breathe normally. This was called the NB session. Half the subjects (selected on a random basis) were given SAV sessions first, followed by NB sessions on the next day. The six remaining subjects had NB sessions on day one and SAV sessions the next day.

Assessment : The sequence of assessment was the same for the recordings made before and after the test periods of both SAV and NB. The sequence was as follows: Subjects were asked to rest for 5 minutes, seated at ease. Oxygen consumption (OC) was recorded for 5 minutes using the closed circuit Benedict-Roth apparatus. Recordings were made almost immediately after waking up in the morning. This was followed by a 10-minute recording of polygraph data viz. heart rate through EKG, skin resistance, respiration, and digit pulse volume as detailed below. The blood pressure (BP) was recorded once at the end of the 10-minute recording. This sequence was repeated at the end of the test period.

Oxygen consumption (OC) was recorded for 5 minutes using the closed circuit Benedict- Roth apparatus. Recordings were made almost immediately after waking up in the morning. Polygraphic recordings were made using a 10 channel polygraph (Model 10, Polyrite, Recorders and Medicare, Chandigarh, India). The EKG was recorded using standard limb lead 1 configuration. The skin resistance (SR) was recorded using specially contoured metal electrodes smeared with electrode jelly (Medicon, Madras, India) and placed in contact with the volar surfaces of the distal phalanges of the index and middle fingers of the left hand. A fixed current of 10 μ A was passed between the electrodes. Respiration was recorded using a volumetric pressure transducer fixed around the trunk about 8 cm below the lower costal margin as the subject sat erect. A photo-plethysmograph was placed on the volar surface of the distal phalanx of the left thumb to record the digit pulse volume (DPV).

The blood pressure was recorded with a standard mercury sphygmomanometer, auscultating over the right brachial artery. The diastolic pressure was noted as the reading at which the Korotkoff sounds appeared muffled. Recordings were made of the (subjective) feelings the subjects experienced at the end of both sessions. Subjects were shown how to monitor their nasal airflow using a method described earlier (Klein, Pilon, Prossner & Shannahoff-Khalsa, 1986), by breathing on a glass slide and noting which patch of mist was smaller and/or faded more quickly.

Data acquisition and analyses : The OC was calculated in ml/min and converted to ml/min Standard Temperature and Pressure Dry (STPD), according to the accepted procedure (Report of the International Union of Physiological Sciences Commission on Teaching Physiology, 1991). Heart rate (HR) in beats per minute (bpm) was obtained by continuously counting the QRS complexes in successive 60 second periods. The skin resistance (SR) trace was sampled every 30 seconds. The amplitude of the digit pulse volume (DPV) was sampled from the peak of pulse wave at 30-second intervals and converted to millivolts (mV) (Roy & Steptoe, 1991).

The data were analyzed using the 2-factor ANOVA, the multiple comparison Tukey test, and the paired t test. The ANOVA was used to determine whether there was a significant difference between SAV and NB sessions (Factor A), the readings before the test period compared to the readings obtained after it (Factor B), and interaction between Factors (A X B). The multiple comparison Tukey test was used to check the least significant difference between different pairs of means. As a second level analysis, the t test for paired data was used to compare the initial and final data of SAV and NB sessions separately.

Pranayama (SAV) and normal breathing (NB) : During both surya anulorna viloma pranayama (SAV) and normal breathing (NB), subjects sat either in padmasana (lotus posture) or sukhasana (sitting cross-legged at ease), with their eyes closed. Surya anuloma viloma pranayama (SAV) involves breathing exclusively through the right nostril, while the left nostril is kept occluded with gentle pressure from the ring and little finger of the right hand (Nagendra, Mohan & Shriram, 1988). During normal breathing (NB) there was no voluntary manipulation of the nostrils.

During the three months prior to the study, the subjects practiced the following yoga techniques:

1. **Asanas:** ardha cakrasana/ lateral arc posture (left and right side), ardha cakrasana/ half-wheel posture, padahastasana/ forward-bend posture, ardha matsyendrasana/ half-twist posture, ustrasana/ camel posture, pascimotanasana/ posterior stretching, bhujangasana/ serpent posture, Salabhasana/ locust Posture, dhanurasana/ bow Posture, sarvangasana/ shoulder-stand, matsyasana / fish Posture, and Savasana/ corpse Posture.

2. **Pranayamas:** sectional breathing, nadisuddhi (purification of subtle perception paths), ujjayi (hissing pranayama), and bhrahmari (bee sounding pranayama).

RESULTS

The group mean values \pm SD for all the parameters have been given in Table 1.

Two Factor ANOVA

The two factor ANOVA revealed a significant difference between the “before” and “after” values of skin resistance-SR (viz Factor B = before test period versus after test period), [F = 8.54, F 0.02 (2) 1,44 = 7.24 hence P < 0.021, here (as well as below) the “F” value for DF 44 has been

Table 1. Autonomic Variables Before and After Surya anuloma pranayama (SAV) and Normal breathing (NB) values are grouped Mean \pm SD, Number of subjects = 12.

Parameters	SAV		NB	
	Before	After	Before	After
Heart rate (bpm)	67.7 \pm 10.0	66.0 \pm 11.0	65.0 \pm 8.1	64.5 \pm 9.0
Respiration rate (cpm)	13.9 \pm 5.4	13.5 \pm 4.8	12.8 \pm 4.4	12.1 \pm 5.2
Skin Resistance (K ohms)	461.3 \pm 312.0	183.0** \pm 159.2@	444.0 \pm 280.0	306.0** \pm 205.7
Digital pulse Volume (mm)	7.0 \pm 2.08	3.8* \pm 1.8	6.6 \pm 4.6	6.7 \pm 5.0
Systolic BP (mm Hg)	100.6 \pm 9.8	110.0* \pm 9.6	104.5 \pm 10.1	101.7 \pm 10.9
Diastolic BP (mm Hg)	74.7 \pm 11.5	72.5 \pm 9.8	71.2 \pm 7.3	69.8 \pm 7.5
Oxygen consumption (ml/ min STPD)	257.4 \pm 54.0	301.1* \pm 51.1	251.6 \pm 40.0	205.3 \pm 59.2

*p < 0.05, paired t-test, "after" compared to "before"

**p < 0.01, paired t-test, "after" compared to "before" @ p < 0.05, Tukey test,

derived by linear interpolation (Zar, 1984) from the values for DF = 40 and DF = 45, given in a standard table. The multiple comparison Tukey test revealed a significant difference between the mean SR value after SAV compared to the mean value before SAV ($q = 3.91$, where $q_{.05}(2, 4, 40) = 3.79$, hence $P < 0.05$). Here 40 is the next value listed on the standard table where 44 is not listed.

For the systolic BP, interaction between Factor A (SAV versus NB) and Factor B (before versus after), i.e., A X B was significant [$F = 4.54$, $F_{0.05}(1, 44) = 4.06$, hence $P < 0.05$]. However, there was no significant effect of either Factors A or B independently ($P > 0.2$, in both cases, DF as described above). There was no significant effect of either of the Factors (A or B) or of the interaction between them (A X B) for the remaining parameters ($P > 0.2$ in all cases, DF as described above). The multiple comparison Tukey test did not reveal a significant difference in the comparison of the group mean values for these parameters (for all parameters $q < 2.50$, DF as described above for SR, hence $P > 0.1$).

Paired t test

The paired t test revealed a significant decrease (45.7%) in digit pulse volume (DPV) following SAV ($P < 0.05$), with no significant change after NB. There was a significant ($P < 0.05$) increase of 17% in the oxygen consumption (OC) after SAV and in the systolic blood pressure after SAV sessions by an average of 9.4 mm HG ($P < 0.05$), but not after NB sessions. The skin resistance (SR) was significantly reduced after both SAV and NB sessions ($P < 0.001$, in both cases). The change was greater after SAV sessions (60%), compared to a 31% decrease after NB sessions. However, this difference was not statistically significant [$q = 1.72$, where $q_{0.5}(2, 4, 40) = 1.996$, hence $P > 0.5$].

There were no significant changes in the other parameters after either SAV or NB sessions, compared to before ($P > 0.1$) in all cases)

DISCUSSION

The present study has demonstrated a significant (paired t test) increase in OC (17%), systolic BP (9.4 mm of Hg on an average), and a significant decrease in digit pulse volume (45.7%), after SAV, with no change in these measurements after NB. After both SAV and NB there was a significant decrease (two Factor ANOVA, Tukey test) in SR.

The immediate effects of SAV on oxygen consumption shown in the present study are similar to the changes in baseline status reported after a month of SAV practice (Telles et al., 1994). This increase in oxygen consumption was considered especially interesting with a possible application in the obese who are known to have a lower Resting Metabolic Rate (RMR) in Kcal/kg/hour than the nonobese (the RMR is negatively correlated with the body mass index, or BMI) (Dudani et al., 1986). This effect is indeed in keeping with the name ('surya anuloma viloma pranayama'), which means "heat generating breathing practice" (Nagendra et al., 1988). In this context it may be mentioned that in the earlier study (Telles et al., 1994) the practice of CAV ("chandra anuloma viloma pranayama" or 'heat dissipating' breathing practice) also increased the OC though the increase was not significant and was of a lesser magnitude than that caused by SAV (24% versus 37%). Hence the name ("heat dissipating") breathing practice may be mainly relative to SAV.

Apart from the effects on OC, the practice of SAV for a month caused an increase in heart rate, suggestive of increased cardiac sympathetic tone and/or reduced vagal tone (Telles et al., 1994). In the present study, immediately after SAV there was a significant reduction in skin resistance (SR) and in digit pulse volume (DPV), both indicative of an increase in sympathetic tone (to palmar sudomotor glands and cutaneous vasculature, respectively). These results support those of previous studies which have demonstrated the sympathetic stimulating effect of forced right nostril breathing (Backon, 1988; Shannahoff-Khalsa & Kennedy, 1993). The increase in systolic BP observed here was probably due to cutaneous vasoconstriction (as shown by the decrease in digit pulse volume). Both SAV and NB sessions caused a significant reduction in the SR. The reduction in SR after NB sessions could indicate an increase in the sympathetic activity in subjects sixty minutes after waking, as a "wearing off" of the increased SR known to occur during sleep (Tart, 1967). All subjects-irrespective of which nostril was dominant at the start of the test session-showed these effects, suggestive of sympathetic stimulation.

It was interesting to note that at the end of the SAV test session, nine of twelve subjects reported feeling more relaxed, while at the end of the NB session eight subjects felt greater relaxation. Among these subjects there were six who reported feeling relaxed after both sessions. In the present study the subjects had practised yoga for three months prior to the study. The practice of yoga has been shown to reduce anxiety and increase quietitude (Hjelle, 1974). Hence, the earlier practice of yoga in the subjects of the present study may have added to the sympathetic stimulating effects of SAV, so that subjects felt more relaxed, though physically they showed signs of sympathetic stimulation. However, it is important to note that the subjects' prior experience of yoga could be expected to condition their autonomic nervous systems, so that their response to SAV may not be the same as that of naive subjects who have no prior experience of yoga.

The way in which breathing through either nostril can influence autonomic functions is not well understood. A study of the electrographic activity generated by nasal (as opposed to oral) breathing (Kristof, Servit & Manas, 1981), showed that this activating effect could also be produced by nasal insufflation without inflating the lung. This neural reflex was abolished after injecting local anesthesia into the nasal mucosa. The afferents arising from the mucosa are believed to be connected to both the hypothalamus (hence the autonomic nervous system) and the cerebral cortex; however, these pathways have not been anatomically defined.

In summary, the practice of SAV may be of benefit in obesity, but in view of the increase in systolic BP and cutaneous vasoconstriction, it may be best to avoid this practice in obese patients who are also hypertensive.

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