Original Article

Effect of Nasal Dominance on Pulmonary Function Test and Heart Rate: A Pilot Study

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Abstract

Background: The nasal cycle is one of the many cyclic events in a human being. Nasal airflow is greater in one nostril at any given point in time and this alternates between right and left nostrils over time. Its periodicity ranges from 25 min to 8 h. This alteration has been known to be controlled by the autonomic nervous system. The current study was designed to assess the effect of nasal dominance during rest on pulmonary function parameters and heart rate. **Materials and Methods:** A cross-sectional study was done on 35 apparently healthy individuals of the age group of 18–30 years. Based on a cold mirror test, the participants were categorized into two groups of right nasal dominance (RND) and left nasal dominance (LND). The parameters recorded were forced expiratory volume in the first sec (FEV_1), forced vital capacity (FVC), FEV_1/FVC, peak expiratory flow rate, forced expiratory flow between 25%-75%, SpO_2, and pulse rate. Data were expressed as mean ± standard deviation and were analyzed using SPSS version 20. **Results:** All pulmonary function parameters exhibited higher values in RND participants compared to LND participants and the difference was found to be statistically significant ($P < 0.05$). **Conclusion:** Nasal dominance has a measurable effect on pulmonary functions and heart rate hence emphasizing the role of autonomic control of airways. This influence can be used as adjuvant therapy for certain disorders.

Keywords: *Autonomic nervous system, nasal cycle, nasal dominance, pulmonary function tests*

Introduction

A fundamental aspect of biological function is the cyclical events ranging from subcellular components to the entire organism.[1] One such large cycle present but nonevident in mammals known as the nasal cycle (NC) was discovered in 1895 by Richard Kayser. The two nasal passages typically carry differing measurements of tidal volumes due to transient asymmetric nasal passage obstruction by engorgement of the erectile tissues in the anterior part of the nasal septum, inferior turbinates, and ethmoid sinuses.[2] One of the earliest researches conducted on NC demonstrates that 80% of the adult population exhibit alternate nasal predominance.[2] This periodicity shifts between the right and the left nostrils from 25 min to 8 h with peak intervals between 1.5 and 4 h.[3] This has been aptly called the ultradian rhythm. In an ideal NC, the air passages should show reciprocal changes of equal amplitude, 180° out of phase, with an identical period and similar mean airflow with total nasal airflow remaining constant.[2] The function of this NC is thought to control the balance between heat and water fluxes on the patent side as well as enable the cells and glands on the congested side to continue with the mucociliary transport.[4]

Nasal dominance is controlled by a central regulator located at the hypothalamus by coordinating the autonomic nervous system (ANS) comprising the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS). The arteries, arterioles, and veins of the nasal mucosa are surrounded by a rich adrenergic plexus. SNS dominance in one of the nostrils causes vasoconstriction and decongestion while simultaneous PNS dominance in the other nostril causes vasodilation, congestion, and engorgement of the anterior nasal septum, inferior turbinates, and ethmoid sinuses.[5] This asymmetrically enlarged tissue physically blocks the passage of air in one of the nostrils more than the other.

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In this biorhythm, if the SNS activity of one nostril drops, immediately the PNS takes over.[6] Parasympathetic activity is increased with left nostril breathing (LNB) as compared to the right and both nostril breathing.[7] The immediate effect of Surya Nadi pranayama (unilateral right nostril breathing [RNB]) practice showed a significant increase in ventilatory capacities and volumes.[8]

ANS may not be the only force driving the NC, it also has a relation with the central nervous system. Studies have shown that there is a strong correlation between the dominant nostril airflow and contralateral brain hemisphere activity. NC reflects the dynamic lateralization of the ANS where the SNS is induced by the left brain hemisphere and PNS by the right brain hemisphere stimulation.[9] Many studies have advocated that forced right uni-nostril breathing provokes increased activity in the left brain hemisphere as depicted by increased oxygenation and blood volume in the left prefrontal cortex (PFC) as compared to the right.[5] Hence, it seems that the three major phenomena, i.e., NC, cerebral dominance, and autonomic activities are somewhat correlated, but how and to what extent remains an enigma. Pingala Nadi stimulates the body when the right nostril is flowing. Ida Nadi stimulates the mental faculties when the left nostril is flowing. When the Swara is alternating, both nostrils become simultaneously active and Sushumna Nadi stimulates the spiritual potential.[10] The NC changes with body posture, age, exercise, emotions, arterial pCO_2, skin temperature changes, handedness, and from person–-to-person.[11-14] Even in the same person, periods vary from cycle to cycle. The NC is also said to be reflected in a host of nonolfactory brain activities as electroencephalography and cognitive task performance.[5] The human system is said to be affected differently by a specific single nostril breathing. A research study demonstrated that LNB significantly enhanced the performance in a spatial task in both males and females, whereas a nonsignificant increase was noted in verbal task performance.[15]

The respiratory system is the only physiological system in human beings which receives innervation from both autonomic and voluntary nervous system. The human airways are innervated through both parasympathetic and sympathetic nerves which synchronize many physiological functions. Parasympathetic neurons provide a dominant supply in the control of airway smooth muscle tone. Stimulation of cholinergic fibers leads to bronchoconstriction in response to the release of the neurotransmitter acetylcholine. On the other hand, sympathetic neurons elicit bronchodilation through adrenergic fibers and adrenergic receptors but the innervation seems sparse.[16,17] Spirometry is a powerful tool that measures the rate at which the lung volume changes during forced breathing maneuvers and can be used to diagnose ventilatory disorders.[18,19] A pulse oximeter is used for measuring oxygen saturation in the peripheral capillaries. Most studies on nasal dominance have been done by forced unilateral breathing maneuvers. However, research work on nasal dominance at rest is limited. Hence, this study was undertaken to determine the influence of nasal dominance at rest on the pulmonary function tests (PFTs), peripheral capillary oxygen saturation, and heart rate.

Materials and Methods

The cross-sectional study was conducted at the Department of Physiology, SMS&R, Sharda University from November 2019 to February 2020. The study has been approved by the Institutional Ethics Committee. Patients with a history of any systemic illness including respiratory diseases within the previous 6 weeks, history of regular medication for any diseases, substance abuse, mental illness, deviated nasal septum, and regular practice of any form of pranayama for the past 6 weeks were excluded from the study.

The study sample comprised 35 apparently healthy right-handed participants of both genders in the age group of 18–30 years. Patients were randomly selected from the students and staff working at Sharda University. The participants were explained about the methodology and implications of the study and written informed consents were obtained. The anthropometric measurements of the participants were recorded and BMI was calculated.

The participants were then asked to be seated comfortably with their back straight and to exhale on a cold mirror.[20] Following exhalation on a cold mirror, two puffs of condensation formed on the mirror one each from the right and the left nostrils. The puff of condensation which took longer to disappear since its time of formation was considered as the dominant side at that moment. Based on this the participant was categorized as either right nasal dominant (RND), left nasal dominant (LND), or equidominant. A finger pulse oximeter was attached to the right index finger and the maximum value of oxygen saturation and the pulse rate (PR) of each participant were recorded.

The PFT of all the participants was performed using RMS Helios 401 computerized spirometer. All the tests were conducted between 10 a.m. and 2 p.m. according to the American Thoracic Society/European Respiratory Society (ATS/ERS guidelines) in a quiet room in sitting position.[21] Before the test, all participants were given a demonstration of the spirometry maneuver and a practice session was held. The participants performed spirometry maneuvers. The parameters tested were forced expiratory volume in the first sec (FEV_1), forced vital capacity (FVC) in liters, FEV_1/FVC in percentage (%), peak expiratory flow rate (PEFR), forced expiratory flow between 25%-75% ($FEF_{25-75\%}$), SpO_2 (Peripheral capillary oxygen saturation), and PR. The nasal dominance was reconfirmed after the PFT. For all these pulmonary function parameters,

percentage predicted values for the respective age, height, and weight were taken into consideration. Figure 1 depicts the flowchart of the study.

Statistical analysis

Data were expressed in the form of mean and standard deviation. Statistical differences between variables of RND and LND participants were tested using Student's unpaired *t*-test in IBM SPSS statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. A $P < 0.05$ was considered to be statistically significant.

Results

A total of 35 participants were enrolled in the study. The cold mirror test revealed that 51% (18) were RND, 43% (15) LND while 6% (2) were equidominant. The participants who were equidominant were excluded from the study. The mean age of the participants was 20.7 ± 2.26 years. Most of the participants were within the normal BMI depicted in Table 1. The interquartile range and percentage predicted values of pulmonary function parameters have been presented in Table 2.

The mean values of all the parameters in left and right dominant participants have been shown in Table 3 where it indicates a significant difference ($P < 0.05$) of all the parameters except FVC and $FEF_{25-75\%}$.

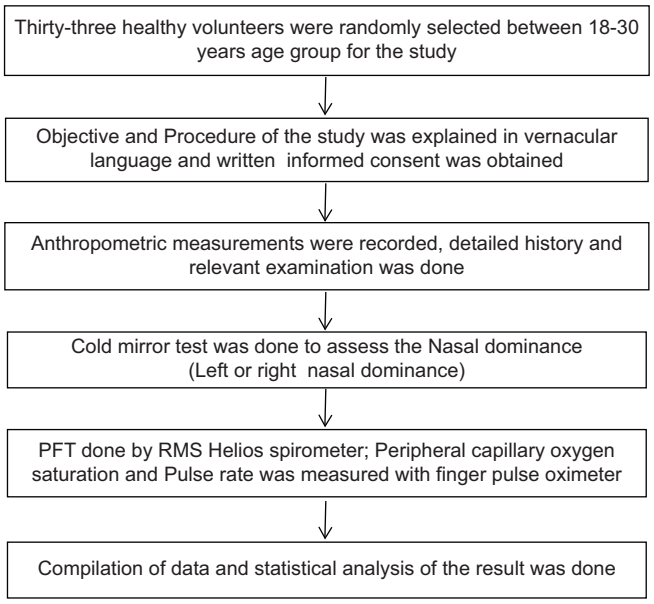

Figure 1: The flowchart of the study

Discussion

The NC is a natural phenomenon of automatic alternating congestion and decongestion of nasal cavities depicting alternation in SNS and PNS. This presents an exemplary case of lateralized neural rhythm which reflects the need of any organism to rest and save energy and is important for our survival.

The present study found that the values of pulmonary parameters (FVC, FEV_1, FEV_1/FVC, and PEFR) of RND were higher than LND participants, and the difference was statistically significant. However, the $FEF_{25-75\%}$ values did not show a significant difference between RND and LND participants. An earlier study done by Keerthi *et al*. showed that there was a significant increase in ventilatory capacities and volumes immediately after Surya Nadi pranayama (RNB).[8]

The current study also revealed that the mean PR and mean peripheral capillary oxygen saturation were significantly higher ($P < 0.05$) in RND participants as compared to LND. Similarly, Shannahoff-Khalsa *et al*. demonstrated that right unilateral forced nasal breathing increases heart rate compared to left.[22] Furthermore, Pal *et al*. reported that basal heart rate, systolic, and diastolic blood pressure parameters after the 6-week practice of RNB were significantly more compared to their prepractice values. Similarly, the values of these parameters were significantly lower in the LNB group compared to their prepractice values.[23] Further, studies have shown that with RNB there is an associated increase in blood pressure, metabolism, and blood glucose levels.[5,24] These results indicate a distinctive RNB effect on sympathetic stimulation that may have therapeutic value.

In contrast, Turankar *et al*. evaluated short-term effect of slow breathing and observed no significant changes in PFT, while an overall decrease in PR was observed in all the volunteers.[25]

The functional purpose of the NC is still a topic of research interest. It is well known that right nostril yoga breathing causes sympathetic activation and left nostril yoga breathing leads to parasympathetic dominance. Right nostril yoga breathing may selectively increase corticotrophin-releasing hormone (CRH) and cortisol by stimulating the paraventricular nucleus and modulation of the HPA axis. The stress neurotransmitter, CRH plays an important role in the activation of the

Table 1: Demographic characteristics of participants

Characteristics	Total participants (*n*=33)	RND (*n*=18)	LND (*n*=15)
Mean age (years)	20.7±2.26	20.95±2.73	20.4±1.55
Gender (male/female)	16/17	9/9	7/8
Mean height (cm)	166.4±8.26	166.8±8.5	165.5±7.86
Mean BMI (kg/m^2)	23.40±3.36	23.72±3.67	23.01±3.01

RND=Right nasal dominant, LND=Left nasal dominant

central sympathetic and serotonergic systems. On the other hand, left nostril yogic breathing suppresses the activation of the paraventricular nucleus thereby causing a decrease in CRH, and cortisol secretion leading to parasympathetic dominance.[26] It is also known that neural connections exist between the CRH neurons in the paraventricular nucleus and noradrenergic neurons in the locus coeruleus (LC). Furthermore, as observed after LNB, the increased parasympathetic response could result in a decrease in both heart rate and respiration that may lead to the stimulation of LC by the paragigantocellular nucleus. Thus, the activation or deactivation of contralateral hemispheres by right or LNB may involve different pathways. The activating and deactivating effects of right and left nostril yogic breathing may be explained by a hypothetical mechanism, which involves PFC deactivation through HPA-LC mediated noradrenaline release and PFC activation via HPA-CRH-Dorsal raphe nucleus mediated serotonin release. The PFC receives serotonergic input and noradrenergic input from the dorsal raphe nucleus of the brainstem and the LC, respectively. Uninostril pranayama breathing practices may influence the PFC through HPA-LC mediated noradrenaline and serotonin release. Studies have revealed that metabolism and autonomic activities can be altered by breathing through a particular nostril. Airflow into the nostrils activates the mechanical receptors in the nasal mucosa. This signal is unilaterally transmitted to the hypothalamus leading to an alteration in the autonomic functions through the HPA axis.[26,27] This could be a plausible physiological mechanism behind the significant spirometric parameter differences found in the RND and LND participants.

Table 2: Interquartile range of pulmonary function parameters of all participants

Parameters	Percentage predicted values (mean)	IQR
FEV_1	97.06±14.33	91-107
FVC	85.15±13.51	81-93
FEV_1/FVC	114.33±7.03	107-121
$FEF_{25\%-75\%}$	99.24±26.12	83-112
PEFR	76.85±16.02	67-80

FEV_1=Forced expiratory volume in 1 s, FVC=Forced vital capacity, PEFR=Peak expiratory flow rate, FEF=Forced expiratory flow, IQR: Interquartile range

Conclusion

The findings of this study demonstrate a significant difference in the values of pulmonary parameters in the RND and LND participants. This indicates an alternating SNS and PNS functions following a shift in right and left nostril dominance over time. Continuous unilateral nostril breathing because of nasal obstruction is mentioned to be associated with several chronic problems such as asthma, migraine, hyperthyroidism, and cardiac dysfunctions.[28-30] Hence, additional research is required with a larger study group and rigorous design to understand the influence of the NC on cardiorespiratory functions.

Limitations

As per the ATS/ERS guidelines for performing PFT, three maneuvers are required to be performed and the best of the three is considered. However, considering the NC is an ultradian rhythm and is subject to change over time during multiple maneuvers, we considered performing a single maneuver. There can be interparticipant differences that could have been reduced by assessing right and LND in the same subject.

Clinical implications

The NC is a possible measure of autonomic arousal in healthy and diseased individuals. ANS disturbances are

Table 3: Effect of nasal dominance with different parameters measured

Parameters	Dominance	*n*	Mean±SD	*t*	df	*P*
FEV_1	LND	15	2.2900±0.79380	−2.189	31	0.036*
	RND	18	2.8644±0.71312			
FVC	LND	15	2.4967±0.55818	−1.979	31	0.057
	RND	18	2.9594±0.74771			
FEV_1/FVC ratio	LND	15	94.1920±4.51914	−2.147	31	0.040*
	RND	18	97.1217±3.30901			
PEFR	LND	15	5.1087±1.40259	−2.084	31	0.046
	RND	18	6.0922±1.30543			
$FEF_{25\%-75\%}$	LND	15	4.0280±1.24447	0.517	31	0.609
	RND	18	3.8233±1.02895			
PR	LND	15	75.8667±10.43255	−2.190	31	0.036*
	RND	18	84.5556±12.05000			
SpO_2	LND	15	96.7333±2.34419	−2.582	31	0.015*
	RND	18	98.4444±1.42343			

*Marked are significant $P<0.05$. LND=Left nasal dominance, RND=Right nasal dominance; FEV_1=Forced expiratory volume in 1 s, FVC=Forced vital capacity, PEFR=Peak expiratory flow rate, FEF=Forced expiratory flow, PR=Pulse rate, SpO_2=Arterial oxygen saturation, SD=Standard deviation

the main cause behind the development of respiratory diseases such as asthma, Chronic Obstructive Pulmonary Disease (COPD), or pulmonary arterial hypertension. In asthma abnormalities of parasympathetic neurons have been suggested whereas in COPD it is the exaggerated response of the sympathetic neurons. Moreover, presently pranayamas on forced unilateral nasal breathing are being used as auxiliary therapy. Therefore, the knowledge of the effects of NC on certain physiological parameters can be of utmost help in knowing the basis of certain pathologies and can be incorporated as a conservative treatment approach to alleviating chronic ailments.

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Conflicts of interest

There are no conflicts of interest.

Ethical clearance

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