Trakia Journal of Sciences, No 1, pp 74-79, 2022

Available online at:
http://www.uni-sz.bg

ISSN 1313-3551 (online) doi:10.15547/tjs.2022.01.011

Case Report

A CLINICAL CASE DEMONSTRATING THE POSSIBLE APPLICATION OF THE SEPARATE REGISTRATION OF NOSTRIL RESPIRATION IN NEUROLOGY

A. Atanasov[1*], T. Manolova[1], P. Zagorchev[2], J. Jovchev[1], G. Arabadgiev[1]

[1]Medical Faculty, Trakia University, Stara Zagora, Bulgaria
[2]Department of Physics and Biophysics, Faculty of Pharmacy, University of Plovdiv, Plovdiv, Bulgaria

ABSTRACT
Introduction: The registration of respiration through the left and right nostrils simultaneously makes it possible to register the dynamics of the nasal cycle.
Aim: To test the method, the nasal cycle of a patient with ischemic stroke of the right posterior cerebral artery territory was measured.
Method: An interface two-channel portable system has been developed for registration of respiration separately through nostrils.
Results: The patient's respiratory and nasal cycle through the left and right nostril was measured for 4.5 hours for three consecutive days (4 days after coming out of the coma). The nasal cycle changed progressively during the healing process. On the first day, an antiphase change in the amplitude of airflow through the left and right nostril was registered with frequency 3 and 1.5 hours. They were accompanied by pronounced somnolence. In the next two days, a nasal cycle reversal of the respiratory airflow through the nostrils was observed. In the process of the patient's recovery, a spontaneous alternative alternation of equalized respiratory airflow through the two nostrils was observed. The patient's recovery was also assessed on the NIHSS scale, whose values correlated over time with the normalization of the nasal cycle.
Conclusion: The method reflects the patient's recovery and can find application in neurology.

Key words: method, neurology, nasal cycle, ischemic

INTRODUCTION

The nasal patency and the nasal resistance of the right and left nostrils in 80% of people are asymmetric. As a consequence, the airflow through the left and the right nostril is not symmetrical. The physiological factors are related to spontaneous congestion and decongestion of the nasal venous sinuses, as well as of the airflow through the left and right nostrils, well known as the nasal cycle [1, 2]. The airflow through the nostrisl increase and decrease alternately at periods between 1.0 and 4.5 hours during the day and period about 3 hours during night sleep [2, 3]. It is established that the nasal cycle is related to the autonomic nervous system, asymmetry in hemisphere blood flow, and asymmetry of EEG brain activity [4, 5]. The nasal cycle is also associated with emotional and metabolic stress, temperature and various states of consciousness. During the night sleep, the nasal cycle is synchronized with the sleep cycle during the REM stage of sleep by the nasal cycle reversal (NCR) [6, 7]. Of practical interest is the hypothesis that the nasal cycle occurs during the conscious states of the brain [8, 9]. The possibility of switching nasal cycles to be performed only during conscious states of mind (awake state and REM dreaming) allows nasal

***Correspondence to:** *Prof. Atanas Todorov Atanasov, Department of physics, biophysics, radiology and rentgenology, Medical Faculty, Armeiska 11 str., Trakia University, 6000 Stara Zagora, Bulgaria, E-mail: atanastod@abv.bg*

cycle to be used as a marker for conscious state in cases of various disorders of consciousness and various neurological diseases. In our work, we present a temperature method for registration of nasal cycle by measuring the temperature of the respiratory airflow simultaneously, but separately through the left and the right nostril. This method has been used in the work of some researchers, but its various modifications continue to improve [3, 6, 10].

AIM

To present and demonstrate the application of the method for breathing registration separately through nostrils in neurology

METHODS AND PATIENTS

Interface 2-channel system- the technical base of the method for breathing registration separately through the nostrils: The developed electronic device (prototype B2C, Sioptic, Plovdiv, Bulgaria) for measuring respiration through both nostrils is based on the reciprocal linear connection between the hydraulic resistance of the nasal cavities and the temperature difference between exhaled and inhaled air. The main steps in making and using the device are described in the previous publication [11].

Patient and control: An 80-year-old woman with concomitant arterial hypertension and atrial fibrillation was examined and hospitalized with clinical and imaging evidence of ischemic stroke in the right posterior cerebral artery (PCA) territory (**Figure 1**). The clinical symptoms were presented with damage to the seventh and twelfth cranial nerve on the left side, left hemiparesis, left homonymous hemianopsia, severe dysarthria and quantitative disturbances of consciousness, assessed on the NIHSS scale. According to the NIHSS scale (as an assessment of the degree of neurological deficit), the patient was assessed with 21 points when admitted with a severe degree of ischemic stroke. Changes in consciousness were observed, from a coma on admission to somnolence and Glasgow score ranging from 18 to 11 points after coming out of the coma. The examination of respiration and nasal cycle was performed 4 days after the partial recovery of the patient's consciousness. Considering the first 4 days, the recordings were made on the 5th, 6th, and 7th days. The patient was discharged on day 8 with a NIHSS score of about 8-9. To compare the patient's breathing and nasal cycle, the breathing and nasal cycles of a clinically healthy 67-year-old man without neurological diseases were taken as control. There isn't data to have a difference between the nasal cycle in males and females and don't depend on the age of patients. Declarations of informed consent were obtained from the patient and control before the study.

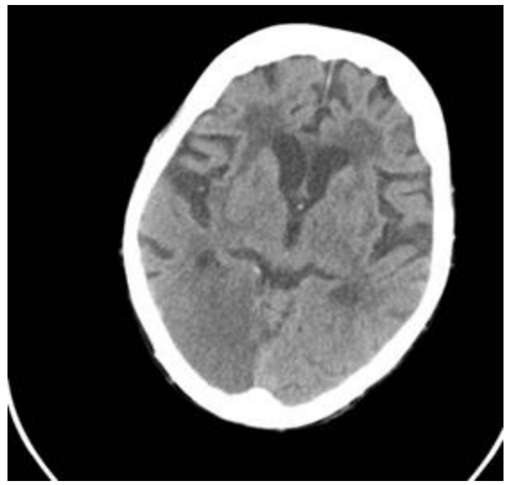

Figure 1. Computed Tomography of the brain of the studied patient with ischemic stroke in the right posterior cerebral artery (PCA) territory.

RESULTS

The patient's breathing and nasal cycle were examined on the 4th day after coming out of the coma - on the 5th, 6th and 7th day. On the days the recordings were made, the patient was in a state of predominant somnolence, which gradually decreased from the 5th to the 7th day. On the 7th day, the condition is close to normal with a predominant waking state of consciousness. The recordings were made at the same time interval of the day (from 2.30 pm to 5.00 pm) (**Figure 2**). During the examination, the patient was on her own breathing, under the supervision of the attending physicians, mainly through the nose. The sensors are inserted into the left and right nostrils of the examined patient, which adapts to them without displaying unpleasant sensations or breathing problems. Throughout the study, the patient lay on her back. This posture is known to be indifferent to the nasal cycle and does not change it [7].

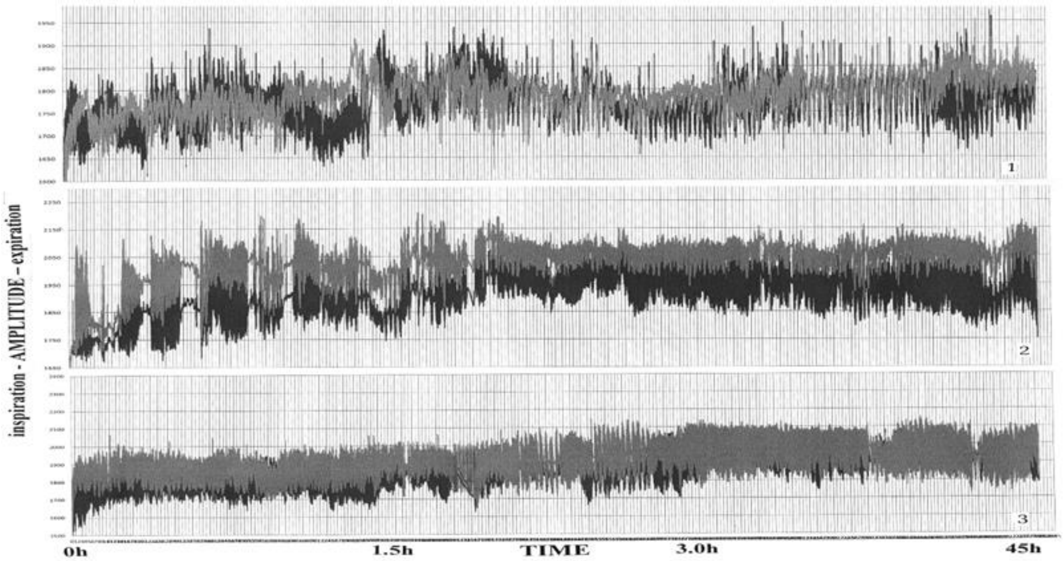

Figure 2. Compressed 1st, 2nd and 3rd recording of breathing and nasal cycle of a woman with ischemic stroke on the 5th, 6th and 7th day after coming out of coma.

In our case, the changes in the nasal cycle are due to changes in the blood supply to the left and right parts of the cerebral hemispheres and their nasal sinuses. This is accompanied by transitions from waking to sleepy state and vice versa, which is classified as a state of somnolence [12].

On the first record /1/ on **Figure 2,** the patient's breathing is sporadically with chaotically alternating periods of sleep and wakefulness The patient's underlying condition is somnolent almost throughout the day. On the second record /2/ the periods of somnolence are observed during the first half of the record. The second part of the record is dominated by the waking state. The third record /3/ is dominated by the awake state of the patient with short periods of sleep and short REM stages. The change in the recordings of airflow through the left and right nostrils (**Figure 2**) correlates with the neurological indicator of neurological deficit assessed on the NIHSS scale. In a coma, the NIHSS index is about 22. On the 5th and 6th day /1st and 2nd record/ NIHSS index decreases to 18-17. On the 7th day /3rd-record / the record of breathing and nasal cycles are closed to normal, and the NIHSS indicator is around 11. It was found that on the 5th day (1st record on **Figure 3**) the left and right nostrils change their patency in anti-phase with periods multiples of 1.5 hours. The nasal patency of the left nostril changes with a period of 3 hours, while the nasal patency of the right nostril changes with a period of 1.5 hours. On the 6th day, the nasal cycle does not show a clear periodicity, but on the 7th day /3rd record / the nasal cycle is normalized and only 1.5 hour temperature changes of the cycle are reported from the record (**Figure 4**). Expanding the records of respiration over time makes it possible to register rapid periodic changes of the order of a few minutes. For example, on the 5th day (on the 1st record) rapid antiphase and in-phase changes of nasal patency with of 7-8 minutes duration were observed (**Figure 5**). On the time-expanded record of the 6th day /record 2/, the patency of the left and right nostrils changes both anti-phase and in-phase. An alternative change in the patency of the nostrils (NCR) is observed about 2 hours after the recording device is switched on (**Figure 6**). Due to NCR, the dominant right nostril (R) with high patency alternates with the left nostril (L) within 2 minutes. There is a rapid change in the dominant airflow from the right to the left nostril, which is referred to as ‘nasal cycle reversal-NCR’ (**Figure 6**). On the unfolded time recording on the 6th day / 2nd record / there is an alternative change of the patency of the nostrils, expressed in periods of equal patency of the left and right nostrils followed by periods of dominant patency of the right nostril. This alternative change in the nostrils occurs spontaneously and is probably associated with rapid changes in the state of somnolence. The somnolence manifests as shortfalls asleep and awakenings recorded in the first half of the 2nd recording. During the day, the patient showed a more pronounced consciousness, which was reported on the Glasgow scale ranging from 18 to 16 points. On the 7th day /3rd the record / the nasal cycle of the patient is close to the normal one, with a periodicity of about 1.5 hours (**Figure 7**). For comparison with the nasal cycle of the patient as a control record was taken the record of the nasal cycles of a healthy person aged 67 years (**Figure 7- control**). On both records, there was a change in nasal patency (NCR) during longer periods of REM-stages of the dreams. On record 3, the patient's NCR is performed during the first longer REM phase of dreaming, while on the control record the NCR is performed during the 2nd longer REM phase of dreaming.

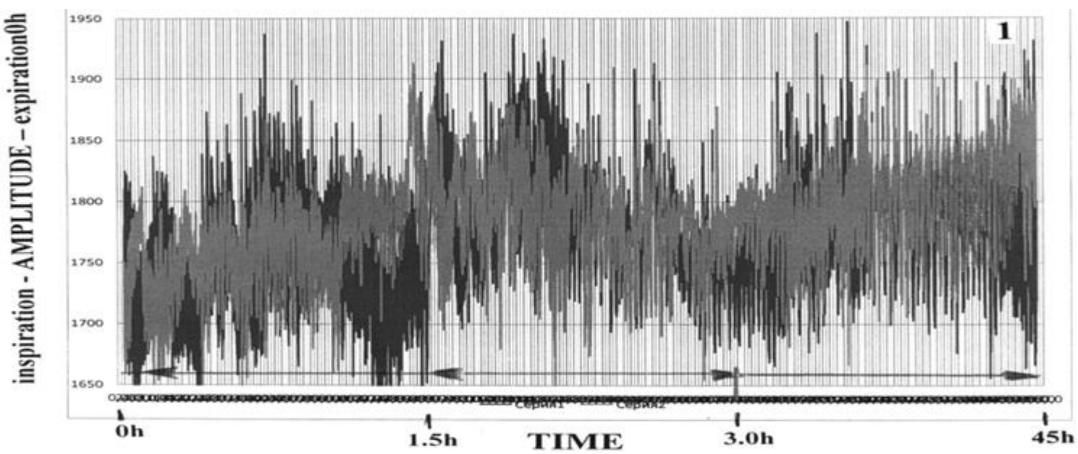

Figure 3. Compressed 1st recording of antiphase change of patency of the left nostril compared to the right with periods of 3 hours and 1.5 hours, respectively.

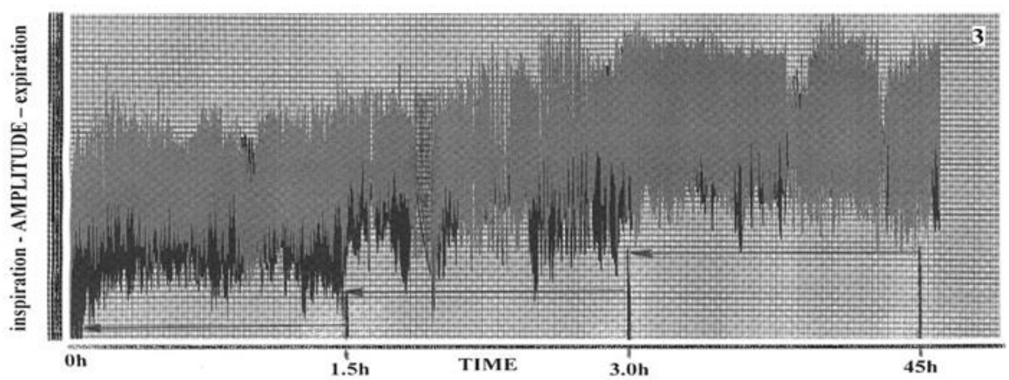

Figure 4. Compressed 3rd record of 1.5 hour periodicities of the nasal cycle of the left and right nostrils (7th day).

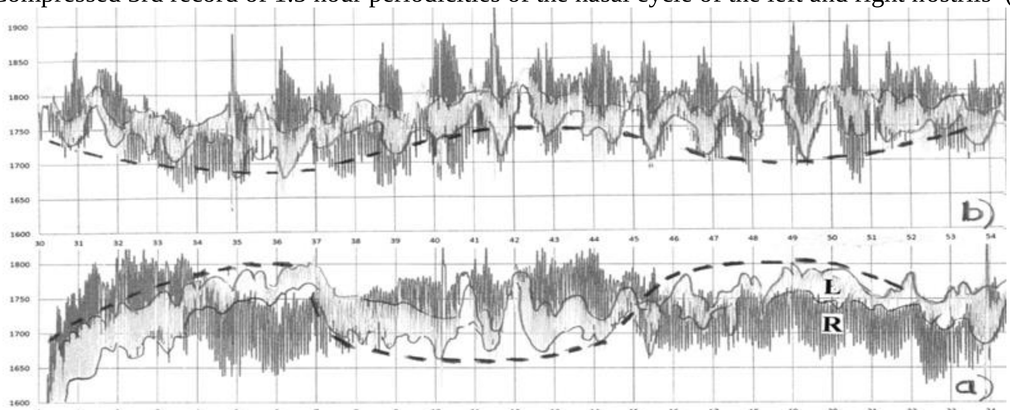

Figure 5. Unfolded in time 1st record of breathing and nasal cycles. Rapid antiphase (**a**) and in-phase (**b**) changes in the patency of the left and right nostrils with periods of 7-8 minutes.

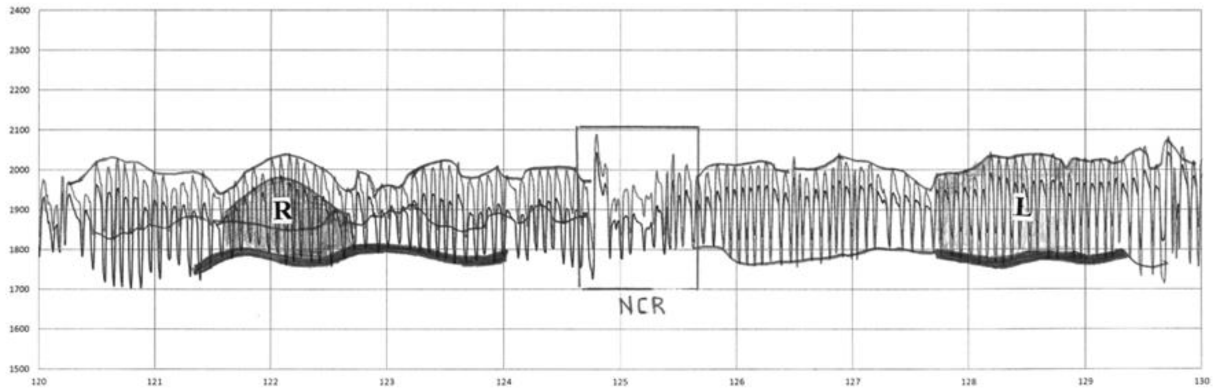

Figure 6. An alternative change in the dominant patency of the nostrils after NCR. Dominant patency of the right nostril (R) after NCR results in dominant patency of the left nostril (L).

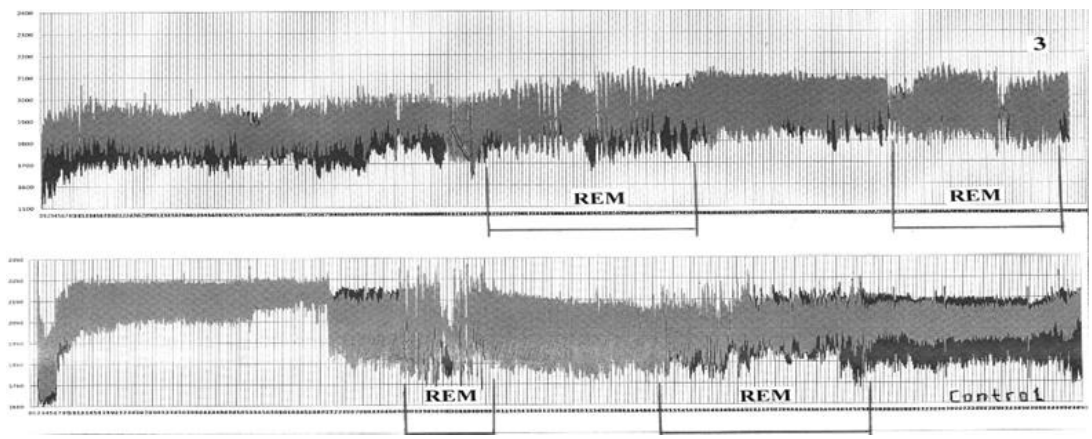

Figure 7. Compressed 3rd recording of the nasal cycles of the patient (**3**), compared to nasal cycle of a healthy 67-year-old person (**Control**). The dream (REM stages) are marked.

DISCUSSION.

The change in the patency of the nostrils in the norm and in various neurological diseases / nasal cycle / can be considered as a physiological mechanism that regulates airflow through the left and right nostrils. Most likely, this regulation has a homeostatic effect on the activity of the whole organism and in particularly on the metabolism and activity of the brain [12-15]. On the records **(Figure 3, 4**) the cyclic changes in the patency of the left and right nostrils with a periodicity of 1.5 hours and 3 hours are multiples to the sleep cycle with periodicity of 1.5 hours. Experimental studies on the average duration of nasal cycle during the day and night confirmed their 1.5 hour periodicity during the day and 3.0 hour periodicity at night [16-19]. Somnolence, which is clearly pronounced after coming out of a coma, decreases over time [12]. This is clearly recorded on the 1st, 2nd and 3rd records and is accompanied by the normalization of respiration and nasal cycle from the 5th to the 6nd and 7th day. An alternative change in the patency of the nostrils was first described by the ancient teaching of Yoga [21]. In our records of the patient with ischemic stroke in the right posterior cerebral hemisphere, a short alternative periodic change in the patency of the left and right nostrils were observed, similar to those described in the Yoga teaching. In Yoga, it is claimed that alternative breathing balances the mental activity of the left and right parts of the brain. In modern experimental medicine, alternative breathing applied to volunteers and patients with certain neurological diseases (in particular to patients with epilepsy) leads to specific changes in the EEG activity of the opposite hemispheres of the brain [22]. This is partially confirmed by observations of the teachings of Yoga. Of practical interest is the question - is there a connection between the location of the ischemic stroke in different cerebral arterial territories and the cyclic patency of the left or right nostril. Only systematic studies of nasal cycles in patients with stroke in different parts of the brain can answer this question [8, 9].

CONCLUSIONS. The results of the study show that the method reflects the patient's recovery and can measure application in the field of neurology.

REFERENCES

1. Hasegawa, M., Kern. E.B. The human nasal cycle. *Mayo Clin. Proceed*., 52, 28-34, 1977.
2. Hanif, J., Jawad, S.S.M., Eccles. R. The nasal cycle in health and diseases. *Clin. Otolaryngol*., 25, 461-467, 2000.
3. Atanasov, A.T., Dimov, P.D., Dimitrov, B.D. Time periods in the nasal cycle during night sleep. *Biol Rhythm Res*., 34(4), 355-366, 2003.
4. Block, R.A., Arnott, D.P., Quigley, B. et al., Unilateral nostril breathing influences lateralized cognitive performance. *Brain Cogn* ., 9, 181-190, 1989.
5. Werntz, D.A., Bickford, R.G., Bloom, F.E. et al. Alternating cerebral hemispheric activity and the lateralization of autonomic nervous function. *Human Neurobiol*., 2, 39-43, 1983.
6. Atanasov, A.T., Dimov, P.D. Nasal and sleep cycle-possible synchronization during night sleep. *Med Hyp*., 61(2), 275-277, 2003.
7. Kimura, A., Chiba, S., Capasso, R. et al. Phase of nasal cycle during sleep tends to be associated with sleep stage. *Laryngoscope***,** 123 (8), 2050-2055, 2013.
8. Atanasov, A.T. Nasal cycle dilemma: nasal cycle is associated to brain Wake/REM states or is associated to consciousness state in them. *OJBIPHY*, 9(1), 1-9, 2019.
9. Atanasov, A.T. Possible connection between the nasal cycle and consciousness. *TJS*, 3, 198-203, 2018.
10. Kumaran, E.M. Alternation in nasal cycle rhythm as an index of the diseased condition. Altered Physiological States. 2018-books google.com
11. Atanasov, A.T., Arabadgiev, G.M., Zagorchev, P. Interface two-channel portable system for 24 hour registration of breathing and nasal cycle. *TJS*, 19(3), 265-272, 2021.
12. Dane, S., Balci, N. Handedness, eyedness and nasal cycle in children with authism. *Int. J. Dev. Neurosci* , DN-1074, No.4., 2007.
13. Rice, A., Eccles, R. Nasal airflow and brain brain activity: is there a link? *JLO*, 130(9), 794-799, 2016.
14. D. Shannahoff-Khalsa, D., Golshan, S. Nasal cycle dominance and hallucinations in an adult schizophrenic female. *Psychiatry Res*., 226, 289-294, 2015.
15. Atanasov, A.T. Stabilizing effect of yawning on nasal cycle. *Global Neurol*., 1(2): 07, 2020.
16. Lang, C.,Crützenmacher, S., Mlynski, B. et al. Investigating the nasal cycle using endoscopy, rhinoresistometry and acoustic rhinometry. *Laryngoscope*, 113, 284, 2003.
17. Ohki, M., Ogoshi, T., Yuasa, T. et al. Extended observation of the nasal cycle using a portable rhinoflowmeter. *J. Otolaryngology*, 34 (5), 346-349, 2005.
18. Kahana-Zweig, R., Geva-Sagiv, M., Weissbroad, A. et al. Measuring and characterizing the human nasal cycle. *PLoS ONE* , 11(10), e0162918, 2016.
19. Tahamiler, R., Yener, M., Canakcioglu, S. Detection of the nasl cycle in daily activity by remote evaluation of nasal sound. *Arch. Otolaryngol. Neck Surg*., 135(2), 137-142, 2009.
20. Baldwin, C.M., Kapur, V.K., Holberg, C.J. et al. Associations between gender and measures of daytime somnolence in the sleep heart health study. *Sleep*, 27, 305, 2004.
21. Gilbert, C. Yoga and breathing. *JBMT*, 3(1), 44-54, 1999.
22. Shannahoff-Khalsa, D.S., Boyle, M.R., Buebel, M.E. The effect of unilateral forced nostril breathing on cognition. Int. *J. Neurosci*., 57, 239-249, 1991.