

Effect of yogic breathing (Paranayam) on pulmonary function tests (PFT) and visual reaction time in healthy individuals

V. S. Shelke¹, A. N. Badwe^{*2} and R. G. Latti³

Rural Medical College, Department of Physiology, Pravara Institute of Medical Sciences (DU), Loni, Tq: Rahata, Dist: Ahmednagar – 413 736

*Correspondence Info:

Dr A. N. Badwe
Associate Professor
Rural Medical College
Department of Physiology
Pravara Institute of Medical Sciences, Loni
Tq: Rahata, Dist: Ahmednagar – 413 736
E-mail: anand.badwe@gmail.com

Abstract

Background: Effects of pranayam are well known to affect various physiological parameters. Practice of pranayam helps to improve pulmonary functions and motor skills.

Aim: It is planned to study the effect of pranayam (Anulom-Vilom and Kapalbhathi) on pulmonary functions tests and visual reaction time in healthy individuals.

Materials: Thirty (n=30) healthy participants between age group of 20-50 years were selected from Loni and surrounding area. These individuals were not suffering from any major disease related with cardiovascular, respiratory, nervous system and any chronic illness.

Methods: All participants underwent pranayam training for three months. Pulmonary function tests were recorded before and during pranayam practice. Visual reaction time was recorded before and after pranayama training.

Conclusion: In present study, it is concluded that, practice of pranayam as per study protocol improves PFT and VRT in healthy individuals. Also emphasize improvement in sensory and motor skills.

Keywords: Pranayam, pulmonary function tests (PFT), visual reaction time (VRT)

1. Background

Yoga breathing or pranayam is the science of breath control. It consists of series of exercise especially intended to meet the body's needs and keeps it in vibrant state.

Various types of pranayam are well known along with its beneficial health effect. The various practices use breathing exercises e.g, suryanamsakar, dhyana, devotional sessions, asanas, kriyas and yogic chair breathing [1][2][3]. Kapalbhathi removes the residual secretions by moving the neck in all directions and forcing out secretions forcefully through the nose. Hence by this mechanism, yoga and naturopathy may be both useful in treating asthma [4].

Pranayam helps to maintain rhythmic pattern of breathing using both nostrils alternately.

This produces balancing effect on the ANS. Practices like short kumbhak or breath holding increases O₂ consumption while, long kumbhak decreases O₂ consumption. Prolongation of breath holding time with increase in forced vital capacity (FVC), forced vital capacity in first second (FVC1), maximum voluntary ventilation (MVV), peak expiratory flow rate and lowered respiratory rate have been reported after six weeks of training in pranayam[5]. Various respiratory parameters improve after yoga and pranayam.

Similarly it is reported that, pranayam influences higher functions of the central nervous system (CNS), such as, perception, planning execution of tasks, learning and memory.

It improves coherence between the two cerebral hemispheres signifying synchronization of logical and intuitive functions. It increases alertness, along with relaxation. Alertness decreases the reaction time of the brain. Twelve weeks training of yoga is known to decrease the visual and auditory reaction times [6][7]. Pranayam alone and mukh (mouth) bhastrika have shown similar effects[8][9]. Spatial tasks are enhanced during left nostril breathing and verbal tasks during right nostril breathing. Breathing through a particular nostril also improves spatial memory scores[10].

From literature survey it is found that, yogic breathing improves pulmonary functions and motor skills. Hence in present study, it is planned to study the effect of pranayama (Anulom-Vilom and Kapalbhathi) on pulmonary functions tests and visual reaction time in healthy individuals.

2. Materials and methods

Thirty (n=30) healthy participants in age group of 20-50 years were selected from Loni and surrounding area. These individuals were not suffering from any major disease related with cardiovascular, respiratory, nervous system and any chronic illness.

Smokers, alcoholics, people suffering from chronic illness like hypertension, diabetes mellitus, COPD were excluded from the present study.

Study was approved by Institutional Ethical Committee. All participants were informed in detail about study protocol and written consent was obtained from them.

The selected participants were called early in the morning after 2 hours of having light breakfast, in laboratory. After recording anthropometric data, pulmonary function tests were performed (Spirovit-SPI, England) and visual reaction time[11] was recorded before beginning of pranayama training. On next day, subjects were called in laboratory and were trained to perform pranayam (breathing exercise) consists of anulom-vilom and kapalbhathi under guidance of trained yoga teacher.

After training, subjects were instructed to perform pranayam (anulom-vilom and kapalbhathi) daily for 15 minutes in the morning for next three months. Participants were called after every 30 days interval for next three month to perform pulmonary function tests. Visual reaction time was recorded after completion of three months period of pranayam practice.

Results were tabulated and data was analyzed by applying student 't' test. P value less than 0.05 was considered as significant

3. Results

Anthropometric data recorded in all participants found to be within normal physiological limits (Table: 1)

Table 1: Anthropometric data of participant

Parameters	(n=30) Mean±SD
Height (cm)	166.8±12.49
Body weight (kg)	58.6±6.43
BMI (kg/m ²)	20.78± 1.87
Buttocks (cm)	37.23±27.47
Forearm (cm)	24.87±6.41
Abdomen (cm)	73.63±5.47
% Fat	14.70± 6.61
Fat mass (kg)	11.9 ±1.38
Free fat body mass (kg)	17.90±1.86

3.1: Pulmonary function tests

PFT parameters (table:2) were recorded in all participants by using digital spirometer (Spirovit 1, UK) which recorded 22 parameters like FVC, FEV₁, etc.

1. FVC (L) (forced vital capacity,) was recorded as per study protocol.FVC increased significantly (P<0.05) after 30,60 and 90 days of pranayam training as compared to value recorded before training.
2. FEV₁ (L) (forced expiratory volume after 1 second) recorded significant increase (P<0.05) in its value after 30 days, 60 days and 90 days of training.
3. FEV₁/SVC (%) (ratio of forced vital capacity at 1 second to slow vital capacity) recorded non-significant marginal decrease in its value as compared to value recorded before training after 30,60 and 90 days of training.
4. FEV 0.2-1.2 (L/Sec) (flow expiratory flow) : The value of this parameter recorded significant increase (P<0.05),after 30 ,60 and 90 days as compared to value recorded before beginning of pranayam training.
5. FEF_{25-75%}, (L/Sec) (forced expiratory flow at 25-75%) recorded gradual increase in its value after pranayama training. Increase in FEF_{25-75%} was found significant after 60 days (P<0.05) as compared to value recorded before training and after 30, 90 days of training. Similarly FEF_{75-85%} recorded gradual increase in its value after 30, 60 and 90 days of pranayam training. This increase was significant after 60 days (P<0.05) as compared to value recorded before training and 30, 90 days of pranayam training.
6. PEFR (L/Min) (peak expiratory flow rate) and PEF_{25%}, PEF_{50%}, PEF_{75%} was also recorded before training and after training of pranayama.

PEFR recorded significant decrease ($P<0.05$) in its value after 30,60,and 90 days of training.PEF_{25%} recorded significant increase in its value after 30,60,and 90 days of training. However, PEF_{50%}, PEF_{75%} recorded significant increase ($P<0.05$) after 60 days of training as compared to 30 and 60 days training.

7. FIVC (L) (forced inspiratory vital capacity) recorded non-significant increase in its value after 30, 60 and 90 days of pranayam training.
8. FIV1 (L) (forced inspiratory air volume at 1 second) and ratio of FIV1/FIVC (%) was determined before and after training of pranayam. FIV1 recorded non-significant increase in its value after 30 and 60 days of training, however a non-significant decrease in its value was recorded after 90 days.

Ratio of FIV1/FIVC recorded marginal non-significant increase in its value after 30 and 60 days of pranayam training however, it was followed by decrease after 90 days of pranayam training.

9. PIF (L/Sec) (peak inspiratory flow) and PIF50% (peak inspiratory flow at 50%) was also recorded before and after pranayam training.PIF recorded non-significant decrease in its value after pranayam training however, PIF50% recorded significant increase ($P<0.05$) in its value after 30,60 and 90 days of pranayam training.
10. SVC (L) (slow vital capacity) was recorded before and after training of pranayam. While

recording SVC instrument also records other parameters like ERV (L) (expiratory reserve volume), IRV (L) (inspiratory reserve volume), TV₁ (L) (tidal volume).

SVC recorded non-significant increase in its value after 30 and 90 days of pranayam training, however after 30 days it recorded non-significant decline its value.ERV recorded gradual increase in its value after 30, 90 days of training. This increase was significant ($P<0.05$) after 30 days of pranayam training.TV₁ after decrease in its value after 30 days of training recorded gradual increase in its value after 60 and 90 days of pranayam training.

11. MVV (L/Min) (maximum ventilator volume) was recorded along with parameters like RR (respiratory rate per minute) and TV₂ (tidal volume) were recorded.

MVV after initial decrease in its value after 30 days of training recorded non-significant gradual increase in its value after 60 and 90 days of pranayam training.

RR recorded significant increase ($P<0.05$) after pranayam training as compared to values recorded before training of pranayam.

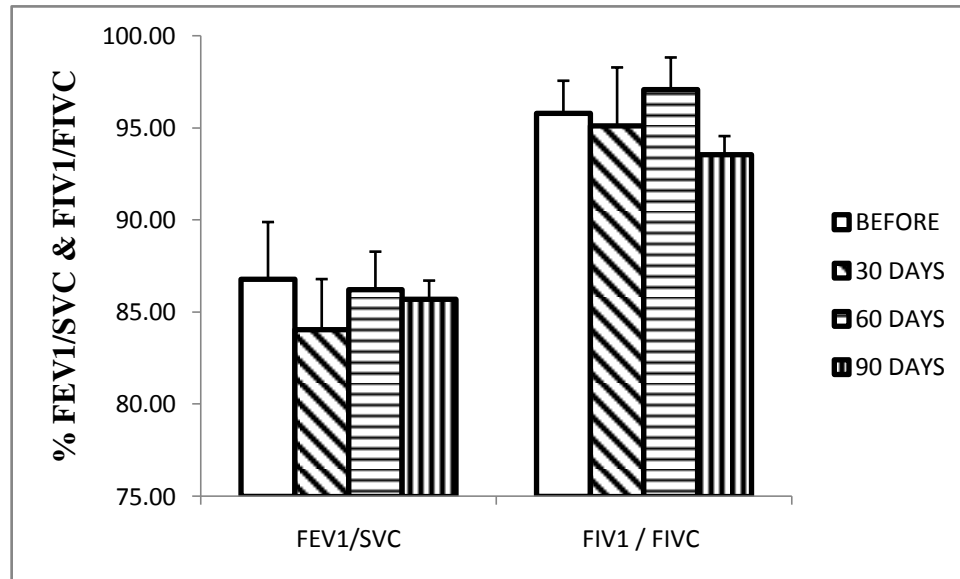
TV₂ recorded increase in its value after 30 and 90 days of pranayama training, while it recorded non-significant decrease after 60 days of pranayam training.

Table 2: Pulmonary function parameters in participants recorded before and after pranayam training

SN	Parameter	Before training	After 30 days	After 60 days	After 90 days
1	F.V.C (L)	3.32±0.56	3.41 ± 0.59*	3.48 ±0.58*	3.62 ± 0.65*
2	FEV1(L)	3.01±0.53	3.15 ± 0.53*	3.23 ± 0.56*	3.30 ± 0.60*
3	FEV1/SVC (%)	86.50±16.37	84.05 ± 15.07	86.22 ± 11.35	85.72 ± 11.45
4	FEF2 - 1.2 (L/Sec)	5.35±1.34	5.78 ± 1.24*	5.95 ± 1.25*	6.09 ± 1.09*
5	FEF 25 - 75%	3.57±0.92	3.72 ± 0.79	3.96 ± 0.99*	3.79 ± 0.76
6	FEF 75 - 85%	1.90±0.56	1.91 ± 0.54	2.10 ± 0.76*	1.86 ± 0.67
7	PEFR (L/min)	5.60±1.78	6.21 ± 1.54*	6.42 ± 1.55*	6.44 ± 1.41*
8	PEFR 25%	5.48±1.42	5.89 ± 1.10*	6.23 ± 1.39*	6.20 ± 1.02*
9	PEFR 50%	3.88±1.04	3.99 ± 0.88	4.20 ± 1.02*	4.12 ± 0.82
10	PEFR 75%	2.17±0.60	2.28 ± 0.66	2.44 ± 0.79*	2.19 ± 0.67
11	FIVC (L)	3.67±1.11	3.70 ± 0.73	3.79 ± 1.08	3.62 ± 0.70
12	FIV1 (L)	3.43±0.58	6.40 ± 15.82	3.60 ± 0.55*	3.40 ± 0.76
13	FIV1 / FIVC (%)	95.80±9.69	98.3 ± 2.72	98.84 ± 1.74	93.57 ± 8.87
14	PIF (L/Sec)	7.33±15.18	5.59 ± 1.53	5.48 ± 1.17	5.52 ± 2.11
15	PIF 50% (L/Sec)	4.40±1.10	5.28 ± 1.52*	5.04 ± 1.17*	5.28 ± 2.16*
16	SVC (L)	3.56±0.68	3.70 ± 0.73	3.22 ± 1.25	3.96 ± 1.15*
17	ERV (L)	0.78±0.32	0.89 ± 0.42	1.12 ± 0.69*	1.05 ± 0.90
18	IRV (L)	1.44±0.41	1.58 ± 0.38*	1.39 ± 0.40	1.57 ± 0.29
19	TV ₁ (L)	11.81±31.64	1.31 ± 0.44	16.47 ± 39.82	1.50 ± 0.46
20	MVV (L/Min)	107.97±37.41	106.76 ± 34.37	115.53 ±37.64	113.26 ± 36.53
21	RR (per minute)	86.26±32.75	104.32 ± 34.59*	104.49 ±32.39	97.59 ± 30.85
22	TV ₂ (L)	1.26±0.81	1.29 ± 0.89	1.25 ± 0.82	1.32 ± 0.76

Values indicate mean±SD; (Paired t test: * $P<0.05$ significant, ** $P<0.01$ highly significant, *** $P<0.001$ very highly significant)

Figure 1: Effect of pranayam training (before, 30 days, 60 days, 90 days of pranayam training) on FEV₁/SVC & FIV1/FIVC in participants



3.2. Visual reaction

Visual reaction time (VRT) was recorded in all participants in right hand and left hand before and after end of the pranayam training.

The value of visual reaction time was recorded less in dominant hand (either right or left hand) as compared to non-dominant hand (either right or left

hand). Non-significant decrease in VRT of right hand was recorded in all participants after end of pranayam training.

VRT of left hand also recorded significant (P<0.05) decrease in its value after end of the pranayama training.

Table 3: Visual Reaction Time in all participants (Before and after pranayam training)

SN	RH/LH	Participants (n=30)	
		Before training	After training
1	Right Hand	217.23±51.37	215.9±50.28
2	Left Hand	234.73±54.13	231.0±51.86*

Values indicate mean±SD; (Paired t test : *P<0.05significant, ** P<0.01highly significant, *** P<0.001 very highly significant)

4. Discussion

From literature survey, it is found that, most of the investigators reported the effect of pranayam on selected pulmonary function tests (PFT) parameters. In present study, effect of two types of pranayam (anulom-vilom and kapabhati) was studied on various types of PFT parameters (total 22 numbers) in all participants. Hence, it became difficult to correlate the findings of this study with other investigators.

The improvement in PFT parameters is correlated with overall improvement in all aspects of pulmonary functions due to increasing efficiency of respiratory muscles, balanced activity of opposing muscles, increase in alveolar ventilation, decreased resistance of both large and small airways also decreases anatomical as well as physiological dead space[12]. Various studies have reported beneficial effect of pranayam on improvement of PFT parameters. Since, pranayam is controlled concise breathing activity which do not only improves

respiratory functions, but also helps to maintain good health.

During anulom-vilom pranayam, inspiration is deep and fills lungs with fresh air, which helps to increase oxygen diffusing capacity across the alveolar wall. In expiration air is forced by contraction of intercostal muscles. This deep inspiration and slow expiration helps to improve efficiency of respiratory muscles[13].

Studied parameters like FVC, FEV₁, FEF_{0.2-1.2}, FEF_{25%}, IRV recorded significant increase after pranayama training. This findings correlate with other investigators [14].

Increase in PEFR may be caused due to increase in thoracic pulmonary compliance and bronchodilation caused by mainly anulom-vilom pranayam. The stimulation of pulmonary stretch receptors by inflation of lungs reflexly relaxes smooth muscles of larynx and tracheobronchial tree, which probably modulates the airway efficiency and reduces airway resistance[15].

During inspiration, pranayam improves respiratory muscle efficiency and lung compliance by reducing elastic and viscous resistance of lungs[15]. It is reported that, pranayama acts as a physiological stimuli for release of surfactant and prostaglandins into alveolar spaces to increase lung compliances. Kapalbhathi pranayama is rapid inhalation and expiration respiratory procedure which helps to clean respiratory tract by expelling mucus or any obstruction present in the respiratory tract. It causes accumulation of CO₂ to stimulate respiratory centres continuously. This helps to increase respiratory rate and ventilator volume[16].

VRT recorded in the right hand, has shorter duration than left hand in all participants. Same types of findings are reported by other investigators also[16]. The right hand being dominant hand, in most of the participants, exhibited enhanced motor activity, hence VRT was of shorter duration for right hand.

Motor conduction velocity being faster in the dominant upper limb (right hand), impulses travel shorter route and have faster conduction velocity as compared to the leg. VRT may vary depending on the time taken by CNS to process the signal (sensory and motor) which is dependent on human behaviour.

Decreases in VRT indicate improved sensory motor performance, since pranayam improves processing ability of CNS[17]. It is also reported that, pranayam stabilizes the autonomic equilibrium causing parasympathetic dominance than sympathetic stimulation [18]. However, reduction in VRT can be correlated with minimum sympathetic stimulation and increased reactivity towards sensory stimulation.

5. Conclusion

In present study, it is concluded that, practice of pranayam as per study protocol improves PFT and VRT in healthy individuals. Also emphasize improvement in sensory and motor skills.

It is felt necessary to create awareness about benefits of pranayam in larger context for whole population in future.

References

- [1] Nagarathan R, Nagendra H R. Yoga for bronchial asthma: a controlled study. *BMJ* 1985; 291:1077-1079.
- [2] Sing K.A non-specific protective factor in management of bronchial asthma. *J of Ashma* 1987; 24(3): 183-186.
- [3] Nagarathan R, Nagendra H R, Seethalaxmi R. Yoga chair breathing for acute episodes of bronchial asthma. *Lungs India* ix 1991; 4:141-144.
- [4] Satyaprabha T N, Murthy H, Murthy B T. Efficacy of naturopathy and yoga in bronchial asthma-A self-controlled study matched scientific study. *India J Physiol Pharmacol* 2001; 45(1):80-86.
- [5] Joshi VD, Gokhale LV. Effect of short term 'Pranayam' practice of breathing rate and ventilator functions of lung. *India J Physiol Pharmacol* 1992; 36(2):105-108.
- [6] Telles S, Nagrathna R, Nagendra HR. Autonomic changes during "OM" meditation. *India J Physiol Pharmacol* 1994; 39(2):418-420.
- [7] Umak, Nagendra R, Nagrathna R, Vaidehi S, Seethalaxmi R. The integrated approach of yoga a therapeutic tool for mentally retarded children: a one year controlled study. *Journal of Mental Deficiency Research* 1989; 33:415-421.
- [8] Borkar AS, Pednekar JR. Effect if pranayama on visual and auditory reaction time. *India J Physiol Pharmacol* 2003; 47(2):229-230.
- [9] Ananda BB, Madanmohan, Udupa K. Acute effect of Mukh Bhastrika (A Yogic Bellows type breathing) on reaction time. *India J Physiol Pharmacol* 2003; 47(3):297-300.
- [10] Naveen KV, Nagendra HR, Nagarathana R, Telles S. Breathing through a particular nostril improves spatial memory scores without lateralized effects. *Psychol Res* 1997;81:555-561.
- [11] Badwe AN, Patil KB, Yelam SB, Vikhe BB. A comparative study of hand reaction time to visual reaction time in Ist MBBS students. *Pravara Medical Review* 2006; 1(1):11-13.
- [12] Suman R, et al. The effect of pranayama on pulmonary function test. *Indian Medical Gazette* 2011; 1:314-318.
- [13] Manaspure SP, Fadia A, Damodara Gowda KM. Effect of Specific Pranayama techniques on Ventilatory Functions of Lungs. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* 2011; 2(4):351-357.
- [14] Joshi N, Gokhale LV. Effect of short term 'pranayam' practice on breathing rate and ventilator functions of Lung. *India J Physiol Pharmacol* 1992; 36(2):105-108.
- [15] Keele CA, Neil E, Norman J. The chemical regulation of respiration. In: Samson Wright's Applied Physiology. 13th ed: Oxford University Press, New Delhi 2003:170-177.
- [16] Srivastav RD, Jain N.A influence of alternate nostril breathing on cardiorespiratory and autonomic parameters. *India J Physiol Pharmacol* 2005; 49(3):469-474.
- [17] Shashikala GV, Shashidhar PK, Baljoshi VS. Effect of mukh bhastrika (a type of pranayama) on sensory – motor performance. *Journal of Clinical and Diagnostic Research* 2011; 5(5):1034-1037.
- [18] Contreras-Vidal JL, Van den Heuvel CE, Teulings HL, Stelmach GE. Visuo-motor adaptation in smokeless tobacco users. *Nicotine Tob Res* 1999; 1: 219-227.