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Effect of Specific Pranayama techniques on Ventilatory Functions of Lungs

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ABSTRACT

With increased awareness and interest in health and natural remedies, breathing techniques are gaining importance and becoming increasingly acceptable to the scientific community. Hence, in the present study, we investigated the beneficial effects of pranayama with reference to FEV_1, FVC and FEV1 / FVC ratio. The participants were divided into control and study groups with 45 members each at the age group of 20±2 years. The study group was asked to perform Kapalbhati, Anulom Vilom, Bhramari and Udgeeth pranayama. The duration of the study was eight weeks. Pulmonary function test was performed in all the participants using computerized pulmonary testing machine and the data obtained was analysed for statistical significance using students 't' test and $p<0.05$ was considered the level of significance. In study group, the FEV_1, FVC and FEV1 / FVC ratios were significantly elevated ($p=0.000$) as compared to that of control group. Since the mechanical factors of the Lung –Thoracic System like FVC, FEV_1, FEV_1/ FVC did show statistically significant changes, the therapeutic exercise programs for sedentary young adults can be best designed to improve the mechanical efficiency of Lung- Thoracic System.

Keywords: Forced expiratory volume during first second (FEV1), Forced vital capacity (FVC) and FEV1 / FVC ratio, Kapalbhati, Anulom Vilom, Bhramari and Udgeeth.

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INTRODUCTION

Modern man is the victim of stress and stress related disorders which threaten to disrupt life totally. With increased awareness and interest in health and natural remedies, breathing techniques are gaining importance and becoming increasingly acceptable to the scientific community.

In modern life, particularly in urban area, due to rapid and vast industrialization the pace of change of life has become very fast, and is unable to understand the rapidly emerging new issues of life. The conceptual framework gets shattered and we become helpless and miserable. This state of misery and consequent deleterious effects on individual and social life, constitute conceptual stress and it has acquired menacing dimensions. Due to overcrowding and increasing building constructions along with increasing pollution, fresh ventilations in houses have been decreased. All these gradually deteriorate the ventilatory ability or functions of human beings. These gradual deteriorating ventilatory functions of lungs may lead to chronic respiratory diseases like bronchial asthma, chronic bronchitis and bronchiectasis.

Breathing exercises improve the functions of respiratory apparatus and improve lung functions. Pranayama, the controlled and conscious breathing, not only improves the respiratory functions, but also improves the general well being of the individual. It helps maintain a better homeostasis and prevents body from degeneration and dysfunctions. Practice of pranayama in its true essence helps the individual to imbibe the higher universal energies and grow him spiritually.

There are various ways to improve ventilatory functions of lungs, one of them is Pranayama. Pranayama is ventilatory function improving technique. Pranayama, prana (life force) and ayama (control), is art of controlled breathing. During breathing for pranayama, deep inhalation (purak) stimulates the respiratory system and fills the lungs with fresh air, retention of air (kumbhaka) raises the internal temperature and plays an important role in increasing the absorption of oxygen, slow exhalation (rechak) causes the diaphragm to return to original position and air full of toxins and impurities is forced out by contractions of intercostal muscles. These are the main components of pranayama which massage the abdominal muscles and tone up the working of respiratory organs of body. This deep inspiration, retention of air and slow expiration increases the overall capacity of lungs and gradually improves the ventilatory functioning of lungs. Due to proper working of these organs, vital energy flows to maintain the normal homeostasis of the body and thus it helps for prevention, control and rehabilitation of many respiratory diseases.

The beneficial effects of different Pranayama are well reported and have sound scientific basis [1-3]. But, there was a scarcity of well studied reports on people living in crowded and polluted metropolitan cities. Hence, in the present study, we made an attempt to investigate the beneficial effects if any, of pranayama in those subjects with reference to Forced expiratory volume during first second (FEV1), Forced vital capacity (FVC) and FEV1 / FVC ratio.

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MATERIALS AND METHODS

This study was conducted in the department of Physiology, Seth G.S. Medical College and K.E.M. Hospital, Mumbai after the institutional ethical clearance. The participants of the study were medical students of age group 18 to 22 years (20±2 years) of both the sexes, after the informed and written consent from all the participants. The duration of the study was eight weeks. Medical students who do not have any acute illness like upper respiratory tract infection, lower respiratory tract infection, gastroenteritis, smoking etc. with normal cardio-respiratory function and those who had not undergone any major surgery was included in the study. Those participants who were doing any other physical exercises, having cardio respiratory problems such as valvular heart disease, asthma, acute illnesses such as upper respiratory tract infection, gastroenteritis, Smokers etc. were excluded from the study.

Stadiometer for measuring height, Weighing Scale for measuring weight and computerized Pulmonary Function test machine manufactured by MEDGRAFICS (CPFS/D USB MedGraphics preVent™ Pneumotach) was used in the present study.

The recruited participants were divided into study group and control group with 45 students each of both the sexes at an age group of 20±2 years. Pulmonary function test was performed in all the participants using computerized pulmonary testing machine. Each individual from the study group was explained about the procedure of pranayama (Kapalbhati pranayama, Anulom Vilom pranayama, Bhramari pranayama and Udgeeth pranayama) in detail and sufficient trials were given for proper understanding. Pranayama was practiced by the subjects of study group for a period of 8 weeks regularly, Monday through Saturday under our direct supervision. At the end of 8 weeks, Forced expiratory volume during first second (FEV1), Forced vital capacity (FVC) and FEV1 / FVC ratio was measured in sitting position.
The various breathing techniques we adopted in the present study are,

Kapalbhati pranayama: Sit in comfortable crossed leg position with back straight, hands resting on knees in dhyana, jnana, shoonya, prana mudra. Face to be relaxed, inhale deeply through both nostril expanding abdomen and exhale with the forceful contraction of abdominal muscles (pull the abdomen in by quickly contracting the abdominal muscles and exhale through the nose). The air is pushed out of lungs primarily by contraction of the diaphragm and secondarily by contraction of all the expiratory muscles. After exhalation inhalation is passive and lungs will be automatically expanded and filled with air. One can begin with 15 respirations. After completing 15 cycles of exhalation and passive inhalation inhale and exhale deeply and take rest pause of about 15 to 20 seconds [4].

Anulom Vilom pranayama: Close the right nostril with thumb, take breathe in from left nostril. Then, open right nostril and close left nostril with middle and ring figure and breathe out from right nostril. Then, breathe in from right nostril, close nostril and open left and breathe out from left nostril.

Bhramari pranayama: Close ears with thumb, index finger on forehead and rest three on base of nose touching eyes. Breathe in and now breathe out through nose while humming "OM" like a bee [4].

Udgeeth pranayama: Sit in comfortable position, close the eyes, and take deep breath and release the air through mouth slowly that sound of "OM" is pronounced [4].
All the breathing techniques were performed for 10 minutes daily.

Statistical Analysis: Percentage change in respiratory rate and breath holding time before and after pranayama was calculated and analyzed for statistical significance using paired't' test. $p<0.05$ was considered the level of significance.

RESULTS

Forced vital capacity (FVC), Forced expiratory volume at the end of first second (FEV1), Ratio of FEV_1/ FVC was measured before and after pranayama exercise of 8 weeks in study group and before the beginning of the experiment and after 8 weeks in control groups, without performing any sorts of exercise using computerized Spiro meter at rest.

Anthropometric measurements:

The participants recruited for the control and study group were almost of the same height, weight and age without exhibiting a statistically significant difference (Table-1).

Table-1: Anthropometric measurements of the control and study groups. N=45 in each group.

Parameters	Control group	Study group
Age (Yrs)	19.23±1.10	19.30±1.06
Height (cms)	157.27±7.31	168.47±4.47
Weight (Kgs)	49.27±6.86	66.73±2.74

Forced Vital Capacity:

Percentage increase in the values of Forced Vital Capacity (FVC) before and after pranayama in young healthy subjects in study group and control group were 1.75% and 0.0% respectively (Table-2). It was found to statistically significant elevation in study groups before and after pranayama ($p=0.000$), whereas the difference was nonsignificant in control group ($p=0.938$).

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Table-2: Forced Vital Capacity in control at the beginning and end of the experimental procedure and in study group before and after pranayama. Values are expressed as Mean± Standard Deviation. N=45 in each group.

Forced Vital Capacity (FVC) in Litres						
	Control group			Study group		
	Beginning of experiment	After 8 weeks	Percentage change	Before Pranayama	After Pranayama	Percentage increase
FVC	3.08±0.27	3.06±0.27	0.0%	4.13±0.28	4.68±0.22	11.75%
t-value	0.079			-23.780		
95% CI	-0.025 to 0.027			-0.597 to -0.501		
p-value	p=0.938 (NS)			p=0.000 (HS)		

Note: FVC = Forced Vital Capacity, CI=Class Interval, NS=Non Significant, HS=Highly Significant.

Forced expiratory volume at the end of first second:

Percentage change in the Forced Expiratory volume at the end of one second (FEV_1) after pranayama in young healthy subjects of study group and control groups were 14.13 % and 0.79% respectively (Table-3). It was found to be statistically significant elevation in study groups before and after pranayama (p=0.000), whereas the difference was nonsignificant in control group (p=0.088).

Table-3: Forced expiratory volume during first second in control at the beginning and end of the experimental procedure and in study group before and after pranayama. Values are expressed as Mean± Standard Deviation. N=45 in each group.

Forced expiratory volume during first second (FEV_1) in Litres						
	Control group			Study group		
	Beginning of experiment	After 8 weeks	Percentage decrease	Before Pranayama	After Pranayama	Percentage increase
FEV_1	2.51±0.27	2.49±0.25	0.79%	3.28±0.28	3.82±0.29	14.13%
t-value	1.767			-43.298		
95% CI	-0.003 to 0.035			-0.565 to -0.514		
p-value	p=0.088 (NS)			p=0.000 (HS)		

Note: FEV_1= Forced expiratory volume during first second, CI=Class Interval, NS=Non Significant, HS=Highly Significant.

FEV_1 / FVC Ratio:

Percentage change in the Ratio of Forced Expiratory Volume at the end of first second (FEV_1) to Forced Vital Capacity (FVC) after pranayama in young health subjects in study group and control group was 2.70 % and 0.17% respectively (Table-4). It was found to statistically significant elevation in study groups before and after pranayama (p=0.000), whereas the difference was non significant in control group (p=0.736).

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Table-4: FEV1 / FVC ratio in control at the beginning and end of the experimental procedure and in study group before and after pranayama. Values are expressed as Mean± Standard Deviation. N=45 in each group.

FEV_1 / FVC ratio						
	Control group			Study group		
	Beginning of experiment	After 8 weeks	Percentage increase	Before Pranayama	After Pranayama	Percentage increase
FEV_1/ FVC ratio	81.63±5.86	81.77±5.34	0.17%	79.03±2.71	81.23±3.73	2.70%
t-value	-0.340			-4.936		
95% CI	-0.934 to 0.668			-3.111 to -1.289		
p-value	p=0.736 (NS)			p=0.000 (HS)		

Note: CI=Class Interval, NS=Non Significant, HS=Highly Significant.

DISCUSSION

The quest for immortality and freedom has always been a fundamental occupation of human civilization. Hatha Yoga is one of these practices. The Vedas are one of the earliest Hindu literatures of hymns consisting mostly of prayers, invocations, and metaphysical speculations of reality. This prototype of Yoga included the elements of concentration, austerities, and regulation of the breath as concerned with the recitation of the hymns, surrender of the ego, and the encounter of a Reality greater than the ego-personality. There were meditative practices as described by the cosmologic hymns of the Vedas. The earliest form of Yoga appears to have been the practice of meditative focusing and sacrificial mysticism.

Bagchi and Wenger studied practitioners of Raj Yoga in India [5] and found a lower respiratory rate and raised Galvanic Skin Resistance with no consistent alterations in heart rate or blood pressure during meditation. Later, Anand B.K (1961) strongly advocated that Yogic practices may modulate the cerebral corticolimbic system of the brain and strengthen the inhibitory components the nervous system. Yogic asanas and pranayama have been shown to reduce the resting rate. Further, they increase the vital capacity, maximum voluntary ventilation, breath holding time and maximum inspiratory and expiratory pressures [4].Two studies by Nagendra and Nagarathna showed the beneficial effects of yoga breathing exercises for asthmatic patients and showed peak expiratory flow rate values improved after yoga, and a majority of patients were able to stop receiving or reduce their cortisone medications. Also showed an overall decrease in asthma attacks and usage of medicine in patients performing yoga breathing [6, 7].

Lakhera and Klain compared pulmonary functions amongst athletes in different Indian populations [8]. The lung function parameters were found to vary in the different settings with results suggesting that the size of the lung is governed by genetic, environmental and nutritional factors. Y J Cheng**,** et.al., reported the similar findings [9]. The probable reason for the observation could be, during pranayama, the compliance of the lung thoracic System increases and the airway resistance decreases, hence forceful expiration becomes more efficient and delayed the onset of fatigue in subjects who were trained as compared to their untrained students and sedentary peers [10, 11].

YJ Cheng et.al. in their cross sectional study showed that men who regularly performing dynamic exercises had higher forced expiratory volume in one second (FEV_1) than the sedentary groups [9]. They also showed that men who regularly did dynamic exercises had difference in Ratio of Forced Expiratory Volume at the end of first second (FEV_1) upon Forced Vital Capacity (FVC) as compared to sedentary groups. The probable reason for the observation may be increase in Forced Expiratory volume at the end of first second (FEV_1) after the pranayama in proportion to increase in Forced Vital Capacity (FVC) after the pranayama. Similar observations were made by James M, et.al, [12]. They concluded that during pranayama, the compliance of the lung thoracic System increases and the air – way resistance decreases. Hence forceful expiration becomes more efficient. Delayed onset of fatigue in subjects who were trained individual as compared to their non-regularly exercising students and sedentary peers.

CONCLUSION

In present study the mechanical factors of the Lung –Thoracic System like FVC, FEV_1, FEV_1/ FVC did show statistically significant changes. Hence we concluded that the therapeutic exercise programs for sedentary young adults can be best designed to delay the onset of fatigue and improve the mechanical efficiency of Lung- Thoracic System.

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