ORIGINAL ARTICLE

COMPARATIVE STUDY OF PULMONARY FUNCTIONS AND BREATH HOLDING TIME IN NADHISUDDI AND SAVITRI PRANAYAMA PRACTITIONERS

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Background: Human being born today also have same physical equipment as the men in prehistoric ancestors, but vast changes have occurred in the environment created by man. Therefore for proper functioning of our body even in the present polluted environment a portion of our time should be spent in practice of yoga. Hence present study was under taken to know the beneficial effect of different types of pranayama on pulmonary functions and breath holding time. **Methods:** Test groups (group I and II) consisted of 72 student volunteers of Rama Krishna institute of moral and spiritual education, Mysore of aged between 18 to 28 years. They practiced Nadhisuddi and Savitri pranayama for 30 minutes daily for 16 weeks. Age and sex matched 36 students of JSS Medical College were included in control group. Pulmonary Function Tests (PFTs) and breath holding time (BHT) was determined after 16 weeks of practice using computerised spirometer and mercury manometer. Appropriate statistical test were applied and results were analysed. **Results:** Both test groups showed significant increase in all parameters measured compared to control group. But there was no change in values of any parameters between the two test groups. **Conclusion:** PFT and BHT increases with either practice of any one type of pranayama. During performance of pranayamic breathing exercise strengthening and control over respiratory muscles are obtained.

Keywords: Nadhisuddi and Savitri Pranayama, PFT, BHT

INTRODUCTION

The classical techniques of Yoga date back more than 5,000 years. The whole system of Yoga is built on three main structures: exercise, breathing, and meditation. Breathing techniques are based on the concept that breath is the source of life in the body. Forth limb of ashtanga yoga is pranayama**.** Pranayama is mainly two words, 'prana' means breath and 'yama' means exercise. 'Prana' suggests the 'life force energy' and 'yama' stands for 'control', expansion/stretching. So the total meaning of 'Pranayama' is to set the control of life and modify 'prana' within the body.

Man has created a new world with different environment and different living conditions than those of his ancestors. These changes have benefited, but have also created problems that are difficult to manage. Human beings born today also have same physical equipment as the children born in prehistoric ancestors and vast changes have occurred in the environment created by man. We are constructed for activity and that regular activity is essential for our optimal health. Therefore a portion of our time should be spent in practice of yoga.

Studies on the effect of yoga, pranayama and meditation on respiratory rate,[1] pulmonary functions,[2–6] and breath holding time,[7,8] have shown significant changes.

This study was undertaken to compare the effect of Nadhi shuddi and Savitri pranayama on pulmonary function tests (PFTs) and breath holding time (BHT) so that if benefits can be obtained by practice of any one type of particular pranayama.

MATERIAL AND METHODS

This study was carried out in Rama Krishna Institute of Moral and Spiritual Education (RIMSE), and Department of Physiology, JSS Medical College, Mysore, India. Informed and written consent was taken from the subjects. Our study did not involve any invasive procedure. Ethical clearance was obtained from Institutional Ethical Clearance Committee.

Seventy-two volunteer students were selected randomly from RIMSE, aged 18–28 years, as the test group. Age and sex matched 36 student volunteers were selected randomly from JSSMC as control group. They did not practice any type of pranayama in the past or during the study. The subjects in the test and control group had no history of allergic disorders, respiratory disorders, and systemic diseases in the past and during the study.

The subjects in the test group were divided into group I and group II. Subjects in group I were

motivated to undergo Nadishuddi pranayama training and subjects in group II were motivated to undergo Savitri pranayama for 30 minutes (4.30 to 5 PM) daily for 6 days in a week for a duration of 16 week.

The volunteers performed initial stretching exercises for 10 minutes before starting particular yoga.

Subjects of group-I practiced Nadishuddhi pranayama. The subject sat in padmasana, kept the left arm straight on knee, the right arm was bent, the thumb was placed on right nostril, the ring finger on left nostril. The other two fingers are held in bent position. Then the right nostril was closed to inhale slowly through the left nostril for a count of six. The breath was held for a count of three while closing both nostrils. Exhaled through the right nostril for a count of six. The breath was held again for three counts by closing both nostrils. Now slowly inhaled through the right nostril for a count of six and hold the breath for a count of three. Exhaled through the left nostril for a count of six and hold the breath out for a count of three.

Subjects of group-II practiced Savitri Pranayama. In shavasana (Lying in supine on a flat surface with the head preferably to the north or east enabling us to be in alignment with the earth's magnetic field. The hands are kept relaxed by the sides of the thighs with the palms facing upwards. Feet are relaxed with heels touching lightly.) Air is Breathed in through the nose for 6 counts and held in for 3 counts. Again air is Breathed out through the nose for 6 counts and then held out for 3 counts. Breathing should be done in and out through both nostril. Repeat 9 rounds.

Anthropometric measurement was done. Weight was measured in kilograms. Readings were taken nearest to ¼ Kg. Weighing machine available in the department of physiology was used and was appropriately calibrated from time to time. Height was measured in meters while standing erect. Readings were taken nearest to 0.005 meters from meter scale.

Respiratory parameter readings were taken using Medspiror®. The subjects were familiarised with the set up and detailed instructions and demonstrations were given to their satisfaction. The subjects were made to breathe out forcefully following deep inspiration into the mouthpiece attached to the pneumatachometer.

Expiration was maintained for a minimum period of 3–4 seconds. Three to four trails of maximal inspiratory and expiratory efforts were made and only the highest reading was taken for data processing. The parameters considered were Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), Forced Expiratory Volume in three seconds (FEV_3) expressed in litres, Peak Expiratory Flow Rate (PEFR) in litres/sec, and Maximum Voluntary Ventilation (MVV) expressed in litres/min. All recordings were done at the basal temperature and pressure.

All the readings were taken in standing position. The tests were done in a quiet room in order to alleviate the emotional and psychological stresses. During the tests, maximum effort from the subjects was ensured by adequately motivating them to perform at their optimum level. Nose clips were not used since there was no significant difference in FVC with the use of nose clips.[9]

For maximum voluntary ventilation mouth piece was placed into the subject's mouth and was instructed to breathe quietly. When the subjects settled, was asked to breathe in and out as rapidly and deeply as possible for 10 seconds.

BHT was measured by Valsalva manoeuvre using mercury monometer. Valsalva manoeuvre consists of forced expiration against a closed glottis after a full inspiration. This leads to increase in intra-thoracic pressure at least 30 to 40 mmHg. According to the specifications laid down in a study[10] a mouth piece was constructed which was required for this study. In sitting posture the subject was asked to blow through the mouth piece after full inspiration until the pressure in the mercury monometer raises up to 40 mmHg and is maintained until the subject can no longer hold the breath voluntarily. The time was noted using a stop watch, this records the BHT.

All tests were carried out at the same time of the day (5:30–6:30 PM) in both test and control groups to avoid possible influence of circadian rhythm. Because of rhythmic changes in physiological functions, it is found to be associated with changes in performance during this period.[11]

Two phases of reading were taken. In test groups, 1st phase of reading was taken before commencement of pranayama practice and 2nd phase of reading at the cessation of pranayama practice that is after 6 weeks. In same way, with same duration readings of two phases were taken in control group also.

Data analysis was done using Independent sample *t*-test and paired *t*-test to find out the significance of difference between the groups selected using SPSS-16.0.

RESULTS

There was significant increase in all parameters recorded in group I and II in second phase of reading when compared with first phase respectively.

Significant increase was also observed in group I and II in second phase than the control group. But there was no significant increase in second phase of reading between group I and II. (Table-1, 2, 3).

Table-1: Comparison of first and second phase of readings of respiratory parameters in test group (G-I)

	FVC (L)	FEV_1 (L)	FEV_3 (L)	PEFR (L/sec)	MVV (L/min)	BHT (sec)
First	2.59±0.28	2.448±0.27	2.58±0.28	4.33±0.41	97.50±7.10	23.52±0.49
Second	3.41±0.41	3.13±0.46	3.39±0.41	6.01± 1.12	119.25±14.4	30.41± 2.5
***p* value**	0.000(s)	0.000 (s)	0.000 (s)	0.000 (s)	0.000 (s)	0.000 (s)

(s): Significant, $p<0.005$

Table-2: Comparison of first and second phase of readings of respiratory parameters in test group (G-II)

	FVC (L)	FEV_1 (L)	FEV_3 (L)	PEFR (L/sec)	MVV (L/min)	BHT (sec)
First	2.57±0.30	2.39±0.3	2.56±0.3	4.36±0.41	95.62±6.22	23.46±0.86
Second	3.46±0.51	3.26±0.49	3.44±0.51	5.96±1.12	117.34±14.46	30.07±3.38
***p* value**	0.000 (s)	0.000 (s)	0.000 (s)	0.000 (s)	0.000 (s)	0.000 (s)

(s): Significant, $p<0.05$

Table-3: Comparison of second phase of readings of respiratory parameters in test groups (G-I and G-II)

	FVC (L)	FEV_1 (L)	FEV_3 (L)	PEFR (L/Sec)	MVV (L/min)	BHT (sec)
Group-I	3.41±0.41	3.13±0.46	3.39±0.41	6.01±1.12	119.25±14.46	30.41±2.5
Group-II	3.46±0.51	3.26±0.49	3.44±0.51	5.9`6±1.12	117.34±14.46	30.07±3.38
***p* value**	0.703 (NS)	0.284 (NS)	0.705 (NS)	0.859 (NS)	0.595 (NS)	0.651 (NS)

(NS): Not significant

DISCUSSION

Increase in FVC, FEV_1, FEV_3 might be due to highly significant increase in vital capacity. Increase in MVV due to improvement in respiratory mechanism and strengthening of respiratory muscles and increase in BHT due to increase in tolerance to high Pco_2 and low Po_2 achieved due to training of pranayama in test group.

Due to pranayama practice there is strengthening of respiratory musculature during which the lungs and chest inflate and deflate to fullest possible extent and muscles are made to work to maximal extent, so there is improvement in lung volumes and capacities. The maximum inflation and deflation is an important physiological stimulus for the release of surfactant and prostaglandins increasing the alveolar spaces thereby increasing lung compliance and decreasing bronchial smooth muscle tone activity. The yogic processes of performing pranayama in fixed posture breathing through alternate nostrils promote vertical breathing. By this vertical breathing all the alveoli of both the lungs open out evenly.

The diaphragm descents 1.5cm during quiet breathing, but during deep vertical breathing it descents 6 to 7 Cm, increasing vertical diameter of thoracic cavity.[12]

Total diaphragmatic surface is 270 Cm^2; every 1 Cm descent of diaphragm will increase the thoracic cage cavity by 270 cc with an intra pulmonary pressure of -3 mmHg. During deep breathing diaphragm descends as a result intra pulmonary pressure will become about -6 mmHg facilitating more air entry into the lungs improving vital capacity.[13]

Nadishuddhi pranayama practice helps to maintain balance between NADIS. It promotes balance between the two nostrils apart from cleansing the nasal tract. Savitri pranayama is an effective way to strengthen respiratory musulature.

By regular practice of pranayama respiratory centre in medulla oblongata is brought under volition. In pranayama the individual continues the phase of inhalation with his strong voluntary control so that lungs are expanded considerably and the walls of the alveoli are stretched to the maximum thus the chest continues to get expended under cortical control. The stretch receptors are thus trained to withstand more and more stretching this helps us to hold the breath for a long period. The duration is gradually increased so that respiratory centre is gradually acclimatised to withstand higher Pco_2 and lower Po_2. The CO_2 stimulates the chemoreceptors located in the medulla oblongata that are sensitive to the amount of CO_2 concentration in blood, which in turn send the impulses to the respiratory centre. The respiratory centre which could have otherwise started exhalation is now helpless against the strong voluntary control from the cortex, so in many ways the individual practicing pranayama is training the chemoreceptor to tolerate more and more tensions.

As the CO_2 goes on accumulating during breath holding, the chemoreceptors report it promptly to the pneumotaxic centre which in form tries to stimulate expiratory centre. The autonomic or the reflex mechanism of respiration is for more powerful than the control from higher centres that is why after a particular stage it is not possible to hold the breath further. The receptors get acclimatised to the increased concentration of CO_2 gradually by regular practice of pranayama.

The respiratory centre is under voluntary control and the respiration can voluntarily arrested for a variable period during any phase of respiratory cycle by inhibitory impulses from higher centres which are able to balance excitatory effect of other

afferents. At the end of breath holding these excitatory impulses increase the sensitivity of the centre to such a level that the voluntary control finally breaks and the respiration commences. Increased tolerance to higher Pco_2 and low Po_2 achieved due to training could prolong BHT in pranayama practitioners.[8]

CONCLUSION

There is significant increase in PFT and BHT in test groups as compared to control group after 16 weeks of practice. No significant changes between test groups suggest that both pranayama are equally beneficial. The cause for this could be regular, slow and forceful inspiration and expiration for prolonged period during pranayama practice. This, by increasing respiratory muscle strength and endurance, may contribute to enhanced voluntary control of breathing.

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