Effect of Savitri Pranayama practice on peak expiratory flow rate, maximum voluntary ventilation and breath holding time

Mamatha SD, Gorkal AR

ABSTRACT

Background: Yoga, an ancient culture of Indian heritage, regular practice leads to ideal physical, mental, intellectual, and spiritual health. Pranayama is one of the yogic practices. These have a number of beneficial physiological effects on various systems in our body. The present work was taken up as data reported on the effect of Savitri pranayama alone on peak expiratory flow rate (PEFR), maximum voluntary ventilation (MVV) and breath holding time (BHT) is scarce.

Aim: To know whether there is any change in PEFR, MVV & BHT in the subjects practicing savitri pranayama and with that of subjects not practicing any type of yoga.

Materials and methods: Two test groups consisting of 30 male student volunteers from Rama Krishna Institute of Moral and Spiritual Education (RIMSE), Mysore, of age between 18 to 28 years were selected. They practiced savitri pranayama for 30 minutes daily for 16 weeks. The control group consisted of age and sex matched 30 students of JSS medical college. PEFR & MVV were determined by using medspiror, a digital spirometer and BHT was determined by using mercury manometer.

Results: The study group showed significant increase in all the parameters measured when compared to control group.

Conclusion: Present study leads to the supposition that Savitri Pranayamic breathing exercise strengthens respiratory muscles and control it by overriding the usual excitatory stimuli to respiratory centres. Hence there is increase in PEFR, MVV & BHT.

Key words: Savitri Pranayama, PEFR, MVV, BHT

INTRODUCTION

Yogic practices, an ancient culture of Indian heritage, have led to ideal physical, mental, intellectual, and spiritual health. Yoga has a number of beneficial physiological effects on various systems in our body. Regular yogic practices have been shown to cause profound improvement in cardiorespiratory,[1] thermoregulatory[2] and psychologic functions in healthy individuals[3]. Yogic practices have been also found to be most useful in alleviating hypertension,[4] bronchial asthma,[5] diabetes mellitus,[6] and coronary artery disease[7]. A previous study has shown that there is significant increase in PEFR in pranayama practicing school children.[8] Combination of various type of pranayama including Savitri Pranayama has also led to significant increase in hand grip strength (HGS), hand grip endurance (HGE), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), forced expiratory volume (FEV), forced expiratory volume in first second (FEV1) and peak expiratory flow rate (PEFR).[9] Statistically significant increasing trend (P<0.01) in percentage predicted peak expiratory flow rate (PEFR), forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), forced mid expiratory flow in 0.25–0.75 seconds (FEF25-75) and FEV1/FVC% in bronchial asthma patients practicing combination of pranayama.[10] Fifteen days regular practice of different types of pranayama[11] and practice of asanas, pranayamas & suryanamaskara[12] has led to increase in the mean breath holding time significantly alone with other parameters.

There is a need to know the effect of Savitri Pranayama (which can be done in Savasana position) training alone on respiratory system, so that benefits, if any, could be obtained by its practice and can be advised in non-ambulatory patients to strengthen respiratory muscles.

MATERIAL AND METHODS

Study was carried out at Rama Krishna Institute of Moral & Spiritual Education (RIMSE), Mysore and at department of physiology JSS Medical College, Mysore. Informed and written consent was taken from the subjects of both the groups. Our study did not involve any invasive procedure. Ethical clearance was taken from Institutional Ethical Clearance Committee.

For the present study, 30 male student volunteers were selected randomly from RIMSE, Mysore of aged 18-28 years as the test group. Age matched 30 male student volunteers were selected randomly from JSS Medical College as control group. They did not practice any type of pranayama in the past or during the present study. They were not practicing or involved in any type of sports or gymnastic activities regularly. Study was carried out only in males to avoid the variation in genders. The subjects in the test and control group had no history of allergic disorders, respiratory disorders, and systemic diseases in the past as well as during the present study. There were no drop outs in the test as well as in control groups during the present study.

Test group practiced Savitri Pranayama for 30 minutes in the early morning between 6:00 am to 6:30 am, 6 days per week for 12 weeks under the guidance of trained yoga instructor. They performed initial stretching exercise for 10 minutes before starting pranayama. The details of Savitri Pranayama procedure is as follows:

Posture

Shavasana i.e., lying supine on a flat surface with the head preferably to the north or east so as to be in alignment with the earth's magnetic field. The upper limbs relaxed and placed by the sides of the thighs with the palms facing upwards. Feet were relaxed with heels touching each other lightly. Air was breathed in through the nose for 6 numeral counts and held in for 3 numeral counts. Again air was breathed out through the nose for 6 numeral counts and then held out for 3 numeral counts. Breathing was done in and out through both nostrils. This was repeated for several rounds.

Method for recording PEFR & MVV

Anthropometric measurement was noted. Peak Expiratory Flow Rate (PEFR) & Maximum Voluntary Ventilation (MVV) were measured using medspiror. The instrument is 'Medispiror' brand by 'Recorders and medicare systems', Chandigarh. It is a type of flow sensing digital spirometer. The instrument is capable of giving reproducible test results and represents the major advancement in computerized pulmonary function testing.

Procedures

The subjects were familiarized with the setup 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. PEFR expressed in litres/sec was noted. For measuring MVV expressed in litres/min, the mouth piece was placed into the subject's mouth and was instructed to breathe quietly. When the subjects settled, they were asked to breathe in and out as rapidly and deeply as possible for 10 seconds, and then MVV was calculated for one minute.

Method for recording BHT

It was measured by valsalva manoeuvre using mercury monometer.

Procedure

According to the specifications laid down in a previous study[13] a mouth piece was constructed which was required for this study. It consists of a hollow PVC tube 15 cm length, closed by a PVC cap at one end with a 2 mm hole in the centre. The other end was connected to PVC reducer. The thickness of the tube was 2 mm with an internal diameter of 3 cm. The bottom of the tube was

connected to a three way stop cock and linked by a 50 cm rubber tube to the mercury manometer.

The subject was asked to blow through the mouth piece in sitting posture, after deep inspiration, until the pressure in the mercury manometer raises up to 40 mm 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.

The term break point is defined as involuntary termination of breath holding in response to the development of net ventilatory stimulus too strong to be further resisted by voluntary effort. Hence, reason for the breaking point is that during breath holding, the pO2 falls and pCO2 rises which stimulates the respiratory centre.

Two recordings were done on both test and control groups. In test group first phase of recording (basal recording) were done before starting pranayama practice & second phase of recording were done after 12 weeks of pranayama practice. Same types of recordings were done on control group also.

To avoid influence of circadian rhythm, the recordings were done between 8.30 am-9.30 am only.[14] The tests were done in a quiet room in order to alleviate the emotional and psychological stresses. During the tests, maximum efforts from the subjects were ensured by adequately motivating them to perform at their optimum level.

Statistical analysis: Data are expressed as Mean ±SD. Data analysis was done using Independent samples't' test to find out the significance of differences between groups selected. Differences in means were considered statistically significant when the two-tailed P value is <0.005.

RESLUTS

First phase recording showed no significant differences in any of the tested parameters between Test and Control groups.

Second phase recordings showed significant differences in all the tested parameters between Test and Control groups.

I. (a) Comparison of first phase of readings in test and control groups and results of independent samples 't' test

	PEFR(L/sec)	MVV(L/min)	BHT(sec)
Test	4.35± 0.42	97.83±7.21	23.54± 0.48
Control	4.35± 0.42	94.63± 5.25	23.24± 0.88
t value	0.000	1.96	1.605
p value	1.000(NS)	0.54(NS)	0.114(NS)

(NS) – Not significant

I. (b)Physical characteristics of the subjects during 1st phase of recordings

	Age	Height	Weight	BMI
Test	21.06±2.42	164.03±3.10	62.41±2.61	23.23±0.79
Control	20.83±2.35	163.66±3.32	62.28±2.78	23.14±1.38
t value	0.379	0.442	0.191	0.312
p value	0.706 (NS)	0.660 (NS)	0.849 (NS)	0.756 (NS)

II. (a) Comparison of second phase of readings in test and control groups and results of independent samples't' test

	PEFR (L/sec)	MVV (L/min)	BHT (sec)
Test	5.872±0.98	119.33±14.95	30.42±2.60
Control	4.32±0.37	98.06± 7.72	23.45±0.63
t value	8.058	6.92	14.25
P value	0.000 (s)	0.000(s)	0.000(s)

(s) – significant- p value < 0.005

II . (b)Physical characteristics of the subjects during second phase of recording

	Age	Height	Weight	BMI
Test	21.06±2.42	164.03±3.10	61.88 ±2.38	23.05 ±0.84
Control	20.83±2.35	163.66±3.32	62.46±2.52	23.24±1.32
t value	0.379	0.442	-0.919	-0.651
p value	0.706 (NS)	0.660(NS)	0.362(NS)	0.518(NS)

DISCUSSION

Yogic asanas and pranayama have shown to reduce the resting respiratory rate. Further, they increase the vital capacity, timed vital capacity, MVV, BHT and maximal inspiratory and expiratory pressures.[15] Respiration is regulated automatically by the neural mechanisms through the respiratory centres (RCs) located in the medulla oblongata and pons. The cyclic waning of sensitivity of RC is

determined by impulses from higher centres, afferent rhythmic discharges modified by pO2 and pCO2 in blood, and impulses from stretch receptors in lungs and thorax. Results of our study showed that practice of Savitri pranayama is an effective way to develop the strength of respiratory muscles and to bring respiration under volition.

PEFR is the maximum flow rate attained during forced vital capacity manoeuvre measured in litres. Its measurement helps to assess the degree of opening of small airway passages. Pranayama involves using of lung spaces, which is not used up in normal shallow breathing. Therefore, the increased peak expiratory flow rate might be a consequence of small airway opening in lungs.[1]

MVV is the maximum volume of air breathed in and out of lungs with maximum voluntary effort in minute (to avoid the effect of increased pCO2 & decreased pO2 during this procedure, recording is done for 10-15 sec and the value is calculated for 1min). It is a test for overall function of respiratory system. It is influenced by the status of respiratory muscles, the compliance of lung-thoracic system, condition of the ventilatory control mechanism and the resistance offered by airways and tissues. The possible explanation for increased MVV could be that regular deep inhalation and expiration of the lungs for prolonged periods has lead to strengthening of respiratory muscles. Therefore, strengthening of respiratory musculature occur incidental to regular practice of pranayamic breathing, during which the lungs and chest inflate and deflate to the fullest possible extent, the muscles are made to work to maximal extent. The maximum inflation and deflation is an important physiological stimulus for the release of surfactant[16] and prostaglandins increasing the alveolar spaces[17] thereby increasing lung compliance and decreasing bronchial smooth muscle tone activity.

During pranayama, an 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 expanded under cortical control. The stretch receptors are thus trained and adopted to withstand increased stretching. This helps an individual to hold the breath for a longer period. The RC as a group is under voluntary control and the respiration can be 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 RC to such a level that the voluntary control finally breaks and respiration commences. Increased tolerance to higher pCO2 and lower pO2 achieved due to training could also prolong BHT.[18] The duration of breath holding is gradually increased as RC is gradually acclimatized to withstand higher pCO2 and lower pO2 in blood. With this we can predict that the RC will dominate over other influences. Therefore in many different ways the individual practicing pranayama is training the stretch receptors to withstand more stretching and to tolerate more and more CO2 tension so that breath can be held for a longer duration. Hence, in pranayama practitioners, there is a gradual increase in BHT as there is increased tolerance to higher pCO2 and low pO2 that are achieved due to training. As this pranayama can be done in savasana position, practice of savitri pranayama may be beneficial in non-ambulatory patients to improve respiratory musculature and bronchial tone.

CONCLUSION

In the test group there is statistically significant increase in PEFR, MVV & BHT after 12 weeks of practice when compared to control group. Savitri pranayama training causes increase in lung and thorax compliance, respiratory muscle strength and tolerance of RC against higher pCO2 and therefore there is significant increase in all the parameters measured.

AUTHOR NOTE

Mamatha SD, Assistant Professor , Contact-9342049717, Email: drpachumamtha@gmail.com **(Corresponding Author)**

Gorkal AR, Professor
Department of Physiology, JSS Medical College, a constituent college of JSS University, Mysore-570015 , Karnataka, India

REFERENCES

1. Subbalakshmi NK, Saxena SK, Urmimala, D'Souza UJA. Immediate effect of 'Nadi-shodhana Pranayama' on selected parameters of cardiovascular, pulmonary, and higher functions of brain. *Thai J Physiol Sci.* 2005;18(2):10–6.
2. Madanmohan, Sivasubramaniyan KM, Balakrishnan S, Gopalakrishnan M, Prakash ES. Effect of six weeks yoga training on weight loss following step test, respiratory pressures, handgrip strength and handgrip endurance in young healthy subjects. *Indian J Physiol Pharmacol.* 2008;52(2):164-70.
3. Ray US, Mukhopadhyaya S, Purkayastha SS, Asnani V, Tomer OS, Prashad R, et al. Effect of yogic exercises on physical and mental health of young fellowship course trainees. *Indian J Physiol Pharmacol.* 2001 Jan;45(1):37-53.
4. Murugesan R, Govindarajulu N, Bera TK. Effect of selected yogic practices on the management of hypertension. *Indian J Physiol Pharmacol*. 2000 Apr;44(2):207-10.
5. Sathyaprabha TN, Murthy H, Murthy BT. Efficacy of naturopathy and yoga in bronchial asthma—A self controlled matched scientific study. *Indian J Physiol Pharmacol.* 2001 Jan;45(1):80-6.
6. Telles S, Naveen KV. Yoga for rehabilitation: An overview. *Indian J Med Sci.* 1997 Apr;51(4):123-7.
7. Manchanda SC, Narang R, Reddy KS, Sachdeva U, Prabhakaran D, Dharmanand S, et al. Retardation of coronary atherosclerosis with yoga lifestyle intervention. *J Assoc Physicians India.* 2000 Jul;48(7):687-94.
8. Sivapriya DV, Subamalani S, Shyamala T. Effect of nadi shodhana pranayama on respiratory parameters. *Recent Research in Science and Technology.* 2010;2(11):32-39.
9. Madanmohan, Lakshmi J, Kaviraja U, Ananda BB. Effect of yoga training on handgrip, respiratory pressures and pulmonary function. *Indian J Physiol Pharmacol.* 2003;47(4):387–392.
10. Candy S, Sheena S, Dandona PK. A study of the effect of yoga training on pulmonary functions in patients with bronchial asthma. *Indian J Physiol Pharmacol.* 2009;53(2):169-174.
11. Ankad RB, Balachandra AS, Herur A, Patil S, Chinagudi S, Shashikala GV. Effect of Short Term Pranayama and Meditation on respiratory parameters in healthy individuals. *International Journal of Collaborative Research on Internal Medicine & Public Health.* 2011;3(6):430-437.
12. Makwana K, Khirwadkar N, Gupta HC. Effect of short term yoga practice on ventilator function tests. *Ind J Physiol Pharmacol.* 1988;32(3):202-206.
13. Black LF, Hyatt RE. Maximal respiratory pressures: Normal values and relationship to age and sex. *Am Rev Respir Dis.* 1969;99:696-702.
14. Rodahl A, O'Brien M, Firth RG. Diurnal variation in performance of competitive swimmers. *J Sports Med Phys Fitness.* 1976 Mar;16(1):72-6.
15. Bijalani RL. Understanding medical physiology, 3rd edition, Jaypee brothers, Noida.2004; p. 897.
16. Hildebran JN, Goerke J, Clements JA. Surfactant release in excised rat lung is stimulated by air inflation. *J Appl Physiol.* 1981 Oct;51(4):905-10.
17. Smith AP. Prostaglandins and respiratory system prostaglandins; physiological, pharmacological and pathological aspects. Edited by SMM. Karim. 1976; 83-102.
18. Bhargava R, Gogate MG, Mascarenhas JF. Autonomic response to breath holding and its variation following pranayama. *Ind J Physiol Pharmacol.* 1988;32(4):257-264.