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Original Research Article

Impact of Slow Breathing Pranayama on Heart Rate Variability

Garg S[1], Chandla SS[2]

[1]Demonstrator, Department of Physiology, SHKM Government Medical College, Nalhar Mewat 122107 India.
[2]Professor, Department of Physiology, Pt. B.D. Sharma PGIMS Rohtak 124001 India.

Corresponding Author: Garg S

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ABSTRACT

Background: Yoga is ancient heritage of India that has given man the answers to his spiritual and holistic search for perfect health and well-being. Pranayama, the fourth limb of ashtanga yoga, plays a significant role in maintaining the autonomic functions of an individual. In today's world of cut throat competition everyone is striving hard to live a natural, healthy and stress free life. Pranayama is a simple and easier way through which one can reduces all his stress, tension and live a healthier disease free life.
Aim: To elucidate the effect of slow breathing pranayama on sympatho-vagal balance.
Material and methods: The study included thirty medical students both male and female of age group 17-21 years. Students practiced anulom-vilom pranayama twenty five minutes daily for three months. Heart Rate Variability (HRV) is measured before, at 6 weeks and at 12weeks of pranayama practice. Parameters included in the study were High Frequency Component (HF), Low Frequency Component (LF) and LF/HF
Results: There occurs a significant increase (p value <.01) in HF component and significant decrease (p value<.01) is observed in LF component and LF/HF.
Conclusion: Anulom-Vilom pranayama plays a significant role in improving the various cardio-vascular functions of an individual. Thus helps in improving the quality of life.

Key words: HF, HRV, LF, LF/HF, Pranayama.

INTRODUCTION

The word yoga is derived from Sanskrit word "Yuj" that means "union". It causes union of soul (atma) with the god (parmatma). Also Yoga is a charaterstic way that helps in maintaining the balance between health and harmony. [1,2] It has a beneficial effect on our body if practiced regularly. Patanjali has described eight-limbs of yoga (ashtang yog). Role of different limbs of yoga are: The first two limbs of ashtang yoga are "Yam" and "Niyam" which are universal morality and personal discipline for the development of our moral, spiritual and social aspects. Third and fourth limbs are "Asan" and "Pranayam" which help in our physical development and improvement of physiological functions and breath control. Fifth and sixth limbs are "Pratyahar" and "Dharna" for controlling our senses and making our mind one-pointed, calm and alert. The last two limbs are "Dhyan" and "Samadhi" which cause inner peace, ecstasy, higher level of consciousness and the ultimate union of our individual consciousness with the Universal Consciousness, resulting in God realization. [3]

Due to increased modernization and industrialization, there has been increased stress which causes deterioration of various

body functions. There occurs a significant increase in cardiovascular disorder due to autonomic imbalance by increase stressers. [4]

Pranayama is a part of the ancient Indian art of yoga, which is the fourth limb of ashtang yoga. It is a controlled and conscious breathing exercise which involves mental concentration. The word Pranayama is derived from two words i.e. "Prana" meaning vital force or life and "Ayama" meaning to control the vital force. Hence pranayama means control of the vital force by concentration and regulated breathing. There are many type of pranayama some common ones are bhastrika, kapalabhati and nadi shodan pranayama. [5]

It basically consists of three phases i.e. Purak (inhalation), Kumbhak (retention) and Rechak (expiration) that helps in controlling the normal breath process. [6] Regular practice of pranayama causes increase in parasympathetic discharge and decrease in sympathetic activity thus leading to beneficial effect on cardiovascular system. Very few studies are available in the literature that shows the effect of particular pranayama on Heart Rate Variability (HRV). So we planned to elucidate the effect of slow breathing pranayama on HRV in students.

MATERIALS AND METHODS

The present study was conducted in the department of Physiology at Pt. B.D. Sharma PGIMS, Rohtak on medical and para-medical students. Thirty students both male and female of 17 to 21 years of age were enrolled randomly in the study which practiced nadi shodhan pranayama (slow breathing exercise) for 12 weeks.

Inclusion Criteria

1. Healthy medical and paramedical students of either sex between 17 and 21 years of age.
2. Students who have not practiced pranayama before enrollment.
3. Students who were committed to practice pranayama as taught by the instructor regularly.

Exclusion Criteria

1. History of smoking and alcohol intake
2. Subjects on long term medications or suffering from any chronic disease including neuromuscular or skeletal disorder.
3. Subjects who do not practice pranayama regularly during the study.

Nadi Shodhan pranayama was performed by subjects as instructed by a certified yoga teacher as detailed below.

Each subject performed nadi-shodhan pranayama as detailed below. The subject sat in sukhasana with eyes closed, neck and head straight. Wrists were kept on the knees on each side with palms facing upwards, elbows slightly bent and kept close to the chest. Middle and index finger of the right hand was placed on the brow of head, thumb was used to close the right nostril and little finger was used to close the left nostril alternately. Elbow of the right hand was kept close to the chest. To start with subjects inhaled slowly through the left nostril to a count of six while the right nostril was closed with thumb. After inhalation, the left nostril was closed with ring and little finger, breath was held for a count of three, subject then exhaled slowly through the right nostril again for a count of six. After completely exhaling, subjects inhaled again slowly through the right nostril for a count of six while right nostril was closed with thumb. Breath was held for a count of three and then left nostril was opened and exhalation was done to a count of six. Inhaling from the left nostril, exhaling from the right and then again inhaling from the right and exhaling from the left nostril completed one cycle. Ten such cycles comprised one set. Each subject performed three such sets with an interval of four minutes. Completing three sets took approximately 25 minutes. [7]

The pranayamic breathing was practiced early in the morning after a warm up for ten minutes by jumping and jogging on the spot. Subjects practiced pranayama with empty stomach or if required only a glass of water was allowed 30 minutes

before starting pranayama. Subjects were required to wear light & comfortable clothing.

HEART RATE VARIABILITY

Heart Rate Variability was recorded by Lab Chart 7 Pro version 7.3.1 software and hardware supplied by AD Instruments, Australia. It was assessed by frequency domain methods. Subject was made to lie down in supine position on a cushioned couch. Three electrodes were attached, one each to palmar side of left wrist, palmar side of right wrist and just above the medial malleolus of left leg. The subject was asked to relax for about two minutes. An artifact free 5 minutes recording of lead II of E.C.G was taken. Recordings with artifacts were excluded for computing the HRV. [8] The following parameters were computed for the study.

High Frequency components in normalized unit (nu)

Low Frequency components in normalized unit (nu)

LF/HF ratio

The following settings were used for recording.

Sampling Rate-The sampling rate in our machine was 256 Hz.

Filters-High Filter- 99 Hz

Low Filter-0.1 Hz

Statistical analysis of data

For interpretation of the results the data set of each group was analysed statistically. To study the effect of slow breathing pranayama on HRV over the time, repeated measure ANOVA was used Significance of results was predicted based on p value. p value >0.05 was taken as non-significant, p value <0.05 was taken as significant and p value <0.01 was taken as highly significant.

RESULTS

The present study was conducted in the department of Physiology at Pt. B.D. Sharma PGIMS, Rohtak on medical and para-medical students. The study was carried out on 30 students of 17-21 years of age of either sex. Their HRV was recorded at basal, 6 weeks and 12 weeks. The observations and results of our study are discussed in the following section:

Table 1: Effect of Nadi Shodhan Pranayama on Hf Component (Nu)

HF	N	Mean	S.D.
BASAL	30	48.666	± 7.651
6 WEEK	30	52.341	± 6.405
12 WEEK	30	55.797	± 5.726

p value <.05, repeated measure ANOVA

Table 1 shows the effect of nadi shodhan pranayama on HF component of HRV over the time. There was a significant increase in HF component of subjects performing the slow breathing pranayama i.e. nadi shodhan pranayama. The increase in HF component was linear from basal 48.666 ± 7.651 to 52.341 ± 6.405 at 6 weeks and 55.797 ± 5.726 at 12 weeks with p value <.05.

Table 2: Effect of Nadi Shodhan Pranayama on Lf Component (Nu)

LF	N	Mean	S.D.
BASAL	30	41.819	± 7.898
6 WEEK	30	35.736	± 9.522
12 WEEK	30	33.528	± 9.127

p value <.05, repeated measure ANOVA

Table 2 shows the effect of nadi shodhan pranayama on LF component of HRV with time. A linear decrease was seen in LF component from basal 41.819 ± 7.898 to 35.736 ± 9.522 at 6 week and 33.528 ± 9.127 at 12 weeks. Results observed were found to be statistically significant in subjects practicing pranayama regularly for 12 weeks with p value <.05.

Table 3: Effect of Nadi Shodhan Pranayama on Lf/Hf Ratio of Hrv

LF/HF	N	Mean	S.D.
BASAL	30	0.894	± 0.286
6 WEEK	30	0.692	± 0.221
12 WEEK	30	0.603	± 0.185

p value <.05, repeated measures ANOVA

Table 3 shows the effect of nadi shodhan pranayama on low frequency and high frequency ratio in relation to time. Linear decrease was seen in LF/HF ratio from basal 0.894 ± 0.286 to 0.692 ± 0.221 at 6 weeks and 0.603 ± 0.185 at 12 weeks. This decrease in LF/HF ratio was found to be significant following the practice of nadi shodhan pranayama for 12 week with p value <0.05.

DISCUSSION

During yoga practice there occurs fully relaxed body and mind that causes higher level of consciousness. [9] In today's world of cut throat competition every single person particularly medical and paramedical students are striving hard to survive and it is taking its toll in the form of negative effects like anxiety, stress, mental tension and depression. Growing population and indiscriminate use of resources has led to polluted environment which further increases the negative effects. [6] Due to increased urbanization and industrialization, risk of various cardiovascular diseases is increasing in the day today life. There are also certain other risk factors like obesity; smoking, sedentary life style etc .that further leads to cardiovascular disease. Majority of risk factors responsible for cardiovascular disease are modifiable.

Pranayama, the fourth limb of yoga, in conjugation with other limbs of yoga plays a significant role in mental health issues like stress management, non-psychotic mood, generalized mood disorder and in case of depression. Pranayama by its beneficial cardio-respiratory effect helps in decreasing most of the negative effects. It is a type of physiological stimuli that leads to adaption of a positive behavior on regular practice. It helps in relaxing and calming the mind. [10]

Autonomic Function disturbance has a direct relation with cardiac activity. Higher the disturbance more is cardiac dysfunctioning and vice-versa.

Autonomic Functions can be assessed by Frequency Domain Component of Heart Rate Variability.

HF component

High Frequency component of HRV determines the parasympathetic outflow, resting vagal discharge and cardiac vagal control. [8]

In our study 30 subjects practiced the slow breathing pranayama that showed a significant increase in HF component, when compared from basal value of 48.666 ± 7.651 to 52.341 ± 6.405 at 6 weeks and 55.797 ± 5.726 at 12 weeks; as shown in Table 1. Increase in HF component may be due to increased oxygen consumption while practicing the pranayama. [11] While practicing the nadi-shodhan pranayama one practices the slow and deep breathing which causes decrease in dead space with increase alveolar ventilation and thus increase in oxygen saturation of blood. [12]

Similar results were obtained in previous studies. Pal et al observed a significant decrease in basal heart rate that reflects increase in parasympathetic outflow which may be due increased oxygenation of tissue following practice of slow breathing pranayama. [13] In another study Dandekar studied the effect of slow breathing pranayama on ANS and concluded a significant increase in HF component that reflects an increase in parasympathetic activity. [14] Sharma and Bhargava concluded a significant increase in parasympathetic discharge after practicing nadi-shodhan pranayama. [15,16] Qairunnisa et al observed a significant improvement in parasympathetic outflow after practicing the slow breathing pranayama. [17]

LF component

The physiological significance of LF as a component of HRV is correlated with the activity of sympathetic nervous system. Practice of slow breathing pranayama causes stimulation of pulmonary stretch receptors which leads to increased inhibitory neural discharge that result in decreased sympathetic tone. [18,19] Sympathetic discharge mainly regulates the DBP which in turn depend upon peripheral vascular resistance. [20]

LF component at Basal level was 41.819 ± 7.898, 35.736 ± 9.522 at 6 weeks and 33.528 ± 9.127 at 12 weeks (Table 2 and Fig. 2) of subjects practicing nadi-shudddhi pranayama were compared. There was a significant decrease in LF component at 12 weeks when compared with basal and 6 weeks. Similar results were observed in various studies that show nadi-shodhan pranayama decreases the LF component. Telles et al observed a significant decrease

in DBP after practicing anulom-vilom pranayama which indicates a decrease in sympathetic outflow. [21] Similar studies conducted by Bhargava and Shrivastava depicted a significant decrease in DBP that signifies decrease in sympathetic discharge following practice of nadi-shodhan pranayama. [16-22] Dhanvijay et al observed a significant decrease in sympathetic outflow that leads to fall in DBP after pranayama practice. [23] Madanmohan et al that depicted a decrease in sympathetic discharge after practicing slow breathing pranayama. [24] Results of our study are consistent with above mentioned study.

LF/HF component

LF/HF ratio is the most sensitive indicator of sympathovagal balance. Increase in LF/HF in resting supine position points towards the increased sympathetic and reduced parasympathetic outflow. [25]

LF/HF ratio of the subjects practicing nadi-shodhan were recorded and compared. Significant decrease in LF/HF ratio was observed at 12 weeks 0.603 ± 0.185 when compared with value at six weeks 0.692 ± 0.221 and basal value 0.894 ± 0.286; as shown in Table 3.

Pal et al observed a significant increase in parasympathetic and decrease in sympathetic outflow following practice of slow breathing pranayama. Thus improving the sympathovagal balance. [13] Dhanvijay et al concluded that after regular training of slow breathing pranayama there was shifting of ANS balance towards parasympathetic side. The sympathetic outflow is lowered and thus causes decreases in LF/HF ratio. [23] Sharma et al observed a significant increase in parasympathetic discharge and decrease in sympathetic outflow after practicing pranayama which reflects a decrease in LF/HF ratio. [15]

CONCLUSION

Effect of nadi shodhan pranayama was studied over the time and it concludes the following:

- Increase in HF component that signifies a increase in para sympathetic discharge.
- Decrease in LF component and LF/HF ratio depicting a low sympathetic activity.

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