International Journal of Research in Medical Sciences
Adhana R et al. Int J Res Med Sci. 2016 Apr;4(4):1027-1030
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20160724

Research Article

Effect of slow breathing training on heart rate, spontaneous respiratory rate and pattern of breathing

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Received: 18 February 2016
Revised: 22 February 2016
Accepted: 18 March 2016

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ABSTRACT

Background: The study was performed to see the effect of slow breathing (6 breaths/minute) training on spontaneous respiratory rate, heart rate and pattern of breathing.
Methods: Sixty subjects between the ages 20-50 years were included in the study. After the rest of 10 -15 minutes in a comfortable sitting posture their baseline heart rate (HR), respiratory rate (RR) and pattern of breathing were recorded on digital polygraph. Then they were guided to do slow breathing maintaining rate of around 6 per minute. Subjects were then instructed to do slow breathing exercise for 8-10 minutes twice daily for next three months. Subjects reported back after three months of practicing slow breathing and their HR, RR, and pattern of breathing were again assessed by digital polygraph.
Results: After three months of practicing slow breathing there was statistically significant reduction in heart rate and spontaneous respiratory rate. Shifting of pattern of breathing from thoracic pattern to abdominal pattern of breathing was also very highly significant.
Conclusions: The study showed that slow breathing technique causes comprehensive change in body physiology by controlling autonomic nervous system. It regularizes rate and pattern of breathing.

Keywords: Slow breathing, Heart rate, Respiratory rate, Pattern of breathing

INTRODUCTION

Breathing process is the manner in which air is inspired or expired has great importance in maintaining health. Rhythmic breathing can be of major significance in determining one's physical and emotional state.[1] Breathing often reflects our state of relaxation or excitation. When at rest, breathing is usually slow and rhythmic, and when tense, breathing may be erratic, or we may hold our breath.[2]

There are many pranayamic techniques described in the ancient literature which have an effect on cardiovascular system. Amongst these are alternate nostril breathing and diaphragmatic breathing. Also some rhythmic and ratio breathing pattern produces the same effect. There are different breathing techniques that essentially work on three main things: regulation of breath, control of vital force and channelization of the *pranas* in right direction.[3] Control of *prana* is regulation of inhalation and exhalation. This is accomplished by eliminating the pause between inhalation and exhalation. Thus, by regulating the motion of the lungs, the heart and the vagus nerve are controlled.[4]

It is known that regular practice of breathing exercises (pranayama) increases parasympathetic tone, decreases sympathetic activity, improves cardiovascular and respiratory functions, decreases the effect of stress and strain on the body and improves physical and mental

health. Slow breathing improves vagal activity. Pranayamic breathing decreases baseline heart rate and blood pressure by improving vagal tone and by decreasing sympathetic discharge.[5]

Thus pranayama is intimately connected with autonomic nervous system and brings its functions under conscious control of the functioning of the lungs.[3] Pranayama, the formal practice of controlling the breath, lies at the heart of yoga. It has power to rejuvenate our body and mind. The ancient sages taught that *prana*, the vital force circulating through the body, can be cultivated and channelled through breathing exercises.[6] The study was undertaken to see the effect of slow breathing training on heart rate, respiratory rate and pattern of breathing.

METHODS

The study was carried out in department of physiology Himalayan institute of medical sciences, Swami Ram Nagar.

A group of 60 volunteers were selected after obtaining written informed consent. Subject proforma was filled up which consisted of general details, any present illness, drug history, past history of any chronic illness and personal history.

Inclusion criteria

- Male and female between 20-50 years
- No history of any chronic illness
- Non- smoker

Exclusion criteria

- Any chronic illness, practicing any yogic exercises.

Study protocol

Ethical clearance was taken by ethics committee. Subjects were instructed to avoid tea, coffee or smoking for at least 6-8 hours before measurement of baseline parameters. Subjects reported in our department between 9 to 10 am. After rest of 10-15 minutes in sitting posture their baseline parameters were recorded on digital polygraph (Medicaid systems, Chandigarh) heart rate, respiratory rate and respiratory pattern. Heart rate was measured in beats per minute monitored by computerized photo plethysmographic sensors of the digital polygraph, which was tied to palmer surface of right thumb tip. Respiratory sensors are strain gauge, consists of long Velcro straps that is tied over chest and abdomen. Regularity of breathing and pattern of breathing were also noted over the graphic pattern.

After the recording of above parameters subjects were guided by investigator to do slow breathing maintaining rate of around 6 per minute. Subjects were asked to inhale while counting 1, 2, 3, 4, 5 and exhale while counting 1, 2, 3, 4 and 5 there was no pause between inhalation and exhalation. Training was given to subjects for one week and then we instruct them to do slow breathing exercise for

8-10 minutes twice a day for next three months.[5] At the end of three months all the three parameters were assessed again by digital polygraph.

Statistical analysis

Wilcoxon signed ranks test was used for analysis of non-normally distributed data. The initial baseline data and data obtained after practicing slow breathing for three months were analysed by SPSS software to compare the differences between the means.

RESULTS

The results are summarized in Table 1. The mean age of the subjects was 40±8 years. The mean BMI was 24±2. Heart rate ($p<0.001$), Respiratory rate ($p<0.001$) declined to a greater extent with very highly statistical significance.

Change in pattern of breathing that is from thoracic to abdominal pattern before and after breathing training was also very highly statistical significance.

Table 1: Effect of 12 weeks training of slow breathing technique on cardiorespiratory parameters (n=60).

Variable		Pre-training	Post training
Hr (beats/min)	Mean±SD (range)	84±6 (74-98)	79±3*** (72-84)
Rr (breaths/min)	Mean±SD (range)	20±2 (15-25)	17±2*** (12-20)
Breathing pattern	Thoracic Abdominal	47 (78.3%) 13 (21.6%)	8(13.3%)*** 52 (86.6%)

"p" value : *<0.05 (significant) ; **<0.01 (highly significant); ***<0.001 (very highly significant); ^>0.05 (not significant).

DISCUSSION

Slow breathing (6 breaths/min) and regulation of respiratory cycle is the most important step in controlling afferent vagal nerve fibres to attain control on autonomic nervous system.[7] Relaxation methods include such techniques as yoga, transcendental meditation, progressive muscle relaxation, pranayama.[8-11] Regular practice of relaxation techniques leads to reduction in sympathetic nervous system activity and increase in vagal activity.[12]

Pal et al had studied autonomic nervous system functions in 30 healthy male subjects. These subjects practiced slow breathing for 3 months regularly and showed improved mental and physical health and reduced stress.[5]

The reduction in the heart rate in subjects in the present study simulates with the observations of Selvamurthy et al who studied the effect of various yogic breathing techniques on heart rate.[13]

In normal resting subjects the heart rate is determined by background vagal activity. The basal heart rate is therefore the function of parasympathetic system.[14]

Grossman, et al observed that prolonged exhalation and other yogic slow breathing techniques promote calmness and parasympathetic dominance. Heart rate slowing during exhalation is the result of greater parasympathetic activity during exhalation.[15]

Yogic breathing technique causes gradual shift in the autonomic equilibrium towards relative parasympathodominance due to decrease in sympathetic activity[13] and this predominance of parasympathetic activity reduces the heart rate.

Yogic breathing technique decreases the activity of sympathetic nervous system to the bronchioles and increases parasympathetic input. Both systems together act on the smooth muscle encircling airways, causing them to constrict, and thereby increases the resistance to airflow. This coincides with the fact that we make use of less alveolar ventilation when we are relaxed.[2]

Respiratory rate of around 5-6 breaths per minute can increase vagal activation and leading to reduction in sympathetic activation, it increases the cardiac-vagal baroreflex sensitivity and it increases parasympathetic activation.[16-19] Slow breathing induced increase in baroreflex sensitivity could be due to the increased tidal volume that stimulates the Hering Breuer reflex an inhibitory reflex triggered by stretch receptors in lungs.[20] Slow breathing increases the oxygen absorption that follows greater tidal volume as a result there is reduction in the anatomical and physiological dead space.[21] This causes another positive effect that is reduction in the need of breathing thus decreasing respiratory rate.

During stress breathing pattern are irregular and a shift to thoracic breathing or chest breathing pattern from abdominal pattern. On the other hand, a shift from thoracic to abdominal dominance of respiratory pattern is seen in response to relaxation, and breathing is regular.[1]

Diaphragm is dominant muscle for quiet breathing in healthy subjects, but increased use of chest muscles and increase breathing rate are common results of stress and may become habitual. Slow diaphragmatic breathing appears to reduce adverse effects of stress and promote parasympathetic cardiovascular dominance.[22]

CONCLUSIONS

Practice of Slow breathing technique reduces spontaneous respiratory rate, heart rate and also regularize the pattern of breathing. It helps in shifting from thoracic breathing pattern to abdominal pattern which is physiologically correct method of breathing. Slow breathing can be helpful in reducing stress and controlling autonomic system.

ACKNOWLEDGEMENTS

Authors are grateful to Himalayan institute of medical sciences for providing facilities to conduct the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Adhana R, Agarwal M, Gupta R, Dvivedi J. Effect of slow breathing training on heart rate, spontaneous respiratory rate and pattern of breathing. Int J Res Med Sci 2016;4:1027-30.