A study on modulation on cardiovascular response to yoga training

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ABSTRACT

Practice of breathing exercises like Pranayama is known to improve autonomic function by changing sympathetic or parasympathetic activity. Specific breathing exercises had continuous good improvement in respiratory endurance in patients suffering Bronchial Asthma. This study was designed to quantity and compare the instantaneous heart rate dynamics and cardiopulmonary interactions during sequential performance of one Yogic meditation breathing patterns with different protocol, Beat to beat heart rate variance and continuous breathing signals from 20 experienced subjects (10 Males; 10 Females;) was assessed. The experienced groups were subjects practicing pranayama for duration to a 2-3years. The autonomic functions of the cardiovascular system of the subjects were assessed in detail. P-Value< 0.05 was considered to be statistically significant , Our results showed no significant change in resting heart rate ( P > 0.05 ) but there was significant increase in deep breathing ( P < 0.05 ), postural tachycardia index ( P < 0.01 ) and valsalva's ratio ( P < 0.01 ). These findings suggest that different meditative breathing protocols may evoke common heart rate effects, as well as specific responses. The results support the concept of a “Meditation paradox”, since a variety of relaxation and meditative techniques may produce active rather than quiescent cardiac dynamics, associated with prominent low frequency, heart rate oscillation or in creases in mean resting heart rate. These findings also underscore the need to critically assess traditional frequency domain heat rate variability parameters in making inferences about autonomic alterations during meditation with slow breathing.

1. Introduction

Yogic techniques like regular practice of breathing exercises (pranayama) are known to improve physical and mental health as they increase parasympathetic tone, decrease sympathetic activity, improve cardiovascular and respiratory functions and decrease the effect of stress and strain on the body [1-3]. Bhattacharya & Krishna swami have given several reports on the beneficial effects of yoga training on physiological functions [4].

Pranayama breathing exercises improve autonomic & pulmonary functions in asthma patients [5]. In the yogic system of breathing, the right nostril dominance corresponds to activation of ‘pingala’ the subtle energy channel of yoga is related to sympathetic arousal and left nostril dominance and Ida’s svara with parasympathetic activation [6]. A significant improvement in cardiovascular endurance & anaerobic power occurs as a result of yoga training[7].

Ancient yogic texts have described a rapid breathing cleansing practice (Kapalabhati) as stimulating, & slow regulated breathing, particularly through alternate nostrils (Nadisuddhi pranayama) as calming [8]. Kapalabhati was found to cause “autonomic activation”. This was observed as an immediate effect during three contiguous sessions of 5 minute each, in terms of an increased heart rate and systolic blood pressure during kapalabhati [9]. In Nadisuddhi pranayama practiced for 4 weeks, there were decreased heart rate, as well as systolic & diastolic blood pressure levels [1].
In Surya anuloma viloma pranayama and Kapalabhati type of breathing exercise there is increase in sympathetic tone or decrease in vagal tone [10]. Practice of short Kumbhak pranayama breathing at slow rate increases oxygen consumption & metabolic rate [11] and other slow breathing exercises reduce chemo reflex response to both hypoxia & hypercapnia but an increase baroreflex sensitivity [12].

The heart rate is controlled by neural as well as other factors. Hence a decrease in heart rate may be related to an increase in vagal tone, a decrease in cardiac sympathetic activity, as well as other non-autonomic factors. Pranayama have definite influence on sympathetic and parasympathetic innervations on modulation of the heart rate and the present study was aimed at analyzing heart rate related to the practice of both Kapalabhati & Nadisuddhi pranayama to get a better understanding about the immediate effects of these practices on the autonomic status.

2. Materials and Methods

The study was conducted in the Department of Physiology, Meenakshi Medical College, Kanchipuram, Tamilnadu. A total of 40 volunteers were selected between the age group of 20-42 years. All of them were non smokers with sedentary lifestyle and free from major health problems. These volunteers were randomly subdivided into study group (n=20) and control group (n=20).

Study group volunteers were given training to learn and perform slow breathing exercises. They were instructed to perform slow breathing exercise for half an hour in the morning between 6 to 7 am and half an hour in the evening between 5 to 6 pm under the guidance of an expert. Various autonomic function tests were performed and the values were recorded before & after the study. The volunteers were instructed not to take tea, coffee or any drinks before the recording. Volunteers of control group were not allowed to perform slow breathing exercises. They were instructed to perform practice of both Kapalabhati & Nadisuddhi pranayama.

The subjects were asked to take rest in supine position for 2 minutes and to stand unaided and remain standing for about a minute while ECG was being recorded continuously. The heart rate change with deep breathing was then expressed as the mean of the difference between maximal & minimal heart rate in 6 respiratory cycles.

2.2. Deep breathing test

The subjects of study group were asked to breath deeply, steadily and slowly for 1 minute at the rate of six breaths per minute, (5 seconds inspiration & 5 seconds expiration) while ECG was being recorded continuously. The heart rate change with deep breathing was then expressed as the mean of the difference between maximal & minimal heart rate in 6 respiratory cycles.

Deep breathing difference = Mean of heart rate difference in 6 breath cycle

Normal : Difference of 15 beats per minute or more.
Borderline : Difference of 10 to 14 beats per minute.
Abnormal : Difference of less than 10 beats per minute.

2.3. Heart rate response to Valsalva maneuver

The subjects were asked to blow out in the rubber tube of the mercury manometer for 10 seconds while maintaining an expiratory pressure of 40 mm of Hg for 10 seconds, a nose clip was applied and small air leakage incorporated in the mouthpiece to ensure that the expiratory pressure comes from the chest & that the subject does not blow with the cheeks. The subjects were made to practice.

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The Valsalva ratio (VR) was calculated as:

\[
VR = \frac{\text{Maximum RR distance after Valsalva maneuver}}{\text{Minimum RR distance during Valsalva maneuver}}
\]

3. Result and Discussion:

The ancient practice of yoga makes use of voluntary regulation of breathing to make the respiration rhythmic & to calm the mind to reach the ultimate goal. This practice of pranayama is an art of controlling the breath. A practitioner of pranayama, not only tries to breathe properly but at the same time tries to keep his attention on the act of breathing, leading to concentration. This act of concentration removes his attention from worldly worries that “distress” him. This may decrease the release of adrenaline. One of the beneficial effects of yogic exercise is to control the autonomic nervous system and visceral functions. So, the present study includes the effect of pranayama breathing on autonemic nervous system and cardiovascular function. As the parasympathetic activity function is more dominant on cardiac function, the tests for parasympathetic function were selected for this study [15-18].

Mean Resting Heart rate was 74.5 beats per minute in study group and 79.85 in controls. These values were statistically significant. Similar responses were observed studied by G.K Pal et al[19].
3.1. Deep breathing test

Deep breathing test indicates the mean differences in heart rate during deep inspiration and deep expiration. The 'p' value is less than 0.05 which indicates that findings are statistically significant. During inspiration, vagal activity decreases and sympathetic activity increases. Therefore, the heart rate rises during inspiration. Opposite mechanism operate in expiration and heart rate decreases. This difference in heart rate in different phase of respiration is called sinus arrhythmia [16]. This phenomenon of arrhythmia is accentuated in deep breathing. Deep breathing test response decreases with increasing age [14]. Normally in adults the deep breathing test response varies from 10 - 15 and a value less than 10 is regarded as abnormal. A significant rise in deep breathing test response in slow breathing group in the present study indicates an increase in vagal activity. Pranayama slow breathing exercise increases oxygen consumption that improves autonomic functions [11]. Also slow type of Pranayama breathing like Nadisuddhi breathing decreases sympathetic activity and fast type of Pranayama breathing like Kapalabhati breathing increases sympathetic activity [10]. The improvement of parasympathetic activity following practice of slow breathing exercise in present study may possibly be due to increased Heart rate changes depend on type of breathing exercises. Slow breathing exercises improve autonomic function; whereas fast breathing exercises do not alter autonomic function. Similar results were observed in the study of Bernardi et al.15 Khannam A et al [5]. studied the effect of yoga in asthma patients. Their study indicates decrease in resting heart rate after yoga training. In normal resting subject, the heart rate is determined mainly by background vagal activity. The basal heart rate is therefore the function of parasympathetic system. In the present study, there was significant decrease in basal heart rate in slow breathing group after three months of slow breathing exercise which improves vagal activity.

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<tr>
<th>Comparison of resting heart rate in controls and subjects</th>
<th>Valsalva's Ratio in control and subjects</th>
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<tr>
<td>[Image showing the comparison of resting heart rate]</td>
<td>[Image showing the comparison of Valsalva ratio]</td>
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<tr>
<td>Mean (pulse/min)</td>
<td>Std. deviation</td>
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<tr>
<td>CONTROL</td>
<td>74.5</td>
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<td>SUBJECT</td>
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<th>Comparison of deep breathing test in controls and subjects</th>
<th>Comparison of Valsalva ratio in group I &amp; II</th>
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<td>[Image showing the comparison of deep breathing test]</td>
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<tr>
<td>Mean</td>
<td>Std. deviation</td>
</tr>
<tr>
<td>CONTROL</td>
<td>16.4000</td>
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<td>SUBJECT</td>
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<td>[Image showing the comparison of Valsalva ratio]</td>
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<td>Mean</td>
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<td>CONTROL</td>
<td>1.0390</td>
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oxygenation of tissues. As oxygenation does not improve in fast breathing due to increased alveolar ventilation, no significant change in autonomic activity was observed in fast breathing group.

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3.2. Postural tachycardia index

Postural tachycardia index indicate the baroreceptor reflex mechanism. The response is more in the study group 1.14±0.16 and this change is statistically significant. On immediate standing there occurs an increase in heart rate, which reaches a maximum between 10th to 15th heart beat. Following this, the heart rate falls to a minimum in 1 to 2.5 minutes and then rises again to stabilize in 2.5 to 4 minutes [14]. In the present study, maximum increase in heart rate is significantly less in subjects of slow breathing group. Our finding is similar to the observations of Bhargava et al[1] that Pranayama breathing decreases base line heart rate and blood pressure by improving vagal tone and by decreasing sympathetic discharge[1]. However, other workers suggested that Pranayama breathing practiced exclusively in right nostril (right nostril pranayama) increased sympathetic activity [17,18]. It was also observed that left nostril breathing decreased sympathetic.

3.3. Valsalva ratio:

Valsalva ratio indicates the integrity of sympathetic and parasympathetic pathways. Valsalva ratio values in controls were 1.16 ± 0.63 and in Subjects that it 1.66 ± 0.44. The 'p' value is less than 0.01 which indicates statistically highly significant. During and after Valsalva manoeuvre, changes in the cardiac vagal efferent and sympathetic vasomotor activity occur, resulting from stimulation of carotid sinus and aortic arch baroreceptors and other intrathoracic stretch receptors [14]. Normally, this causes a sharp reduction in venous return and cardiac output & blood pressure falls. The effect on the baroreceptors is to cause a reflex tachycardia and to a lesser extent, peripheral vasoconstriction. With release of intrathoracic pressure, venous return, stroke volume, and blood pressure rise to higher than normal levels. Parasympathetic influence then predominates and results in bradycardia.

The above results indicate that parasympathetic activity increases and sympathetic activity decreases in subjects doing regular slow breathing Pranayama exercises.

4. Conclusion

The results of the present study in the Pranayama practicing subjects indicate improvement in parasympathetic activity on cardiovascular system. There was significant decrease in basal heart rate in the study group practicing slow breathing exercises which indicates improvement in vagal activity (vagal tone). It is evident from the present study that yoga develops an ability to control cardiovascular autonomic function and can be prescribed as an adjuvant therapy in cardiovascular diseases.

5. References


