Original Research Article

Resting heart rate variability in regular yoga practitioners – A cross-sectional study

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Abstract

Heart rate variability (HRV) is a useful and powerful non-invasive tool for quantitative assessment of cardiac autonomic function. Recent studies have shown that low heart rate variability is an indication of increased risk for cardiac diseases and sudden cardiac death. Yoga has been associated with improved cardio-respiratory performance. Thirty male regular yoga practitioners doing yoga for more than 3 years, age between 25-45 years (yoga group) and 30 male non-yoga practitioners, age-matched (control group) were included. A computerized Niviqure ECG system with HRV software was used for heart rate variability recording. Our results show that frequency-domain parameters like LF power, LF n.u, and LF/HF ratio were significantly lower in yoga group compared to control group. Time-domain parameters like mean RR, NN50, pNN50 were significantly higher in yoga group compared to control group. We conclude that the yoga increases heart rate variability by optimizing the autonomic functions, which is a good indicator of cardiac autonomic activity during rest.

Keywords

Autonomic function
Cardiac diseases
Resting heart rate variability
Yoga

Introduction

Heart rate (HR) is influenced by sympathetic and parasympathetic nervous systems. Heart rate variability (HRV) can be used as a quantitative marker of the autonomic nervous system and is an important index to assess cardiovascular diseases such as hypertension, rhythm disorders, ischemic heart disease, etc [1]. The autonomic nervous system (ANS) is responsible for regulating physiological processes during both healthy and diseased states. The sympathetic system stimulates cardiovascular system (CVS) functioning resulting in increased heart rate, increased stroke volume, systemic vasoconstriction, etc. while the parasympathetic nervous system is charged with the inhibitory tasks of decreasing heart rate, decreasing stroke volume, systemic vasodilatation, etc [2].

HRV is an easy, non-invasive measure for investigating the autonomic influence on the cardiovascular system. HRV describes the variations between consecutive heart beats. These changes from beat to beat occur during physiological responses to various stimuli, including breathing, exercise, mental stress, metabolism, sleep, and even attempt to compensate for the deranged state associated with the disease. The autonomic influence on the cardiovascular system may be evaluated by time-domain and frequency-domain parameters of HRV. A simple method to quantify overall HRV is time-domain analysis, whereas power spectral analysis reveal about different mechanisms.

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Yoga is an old system of meditation having psychological, somatic and spiritual components that helps to achieve a harmony between mind, body, and soul. Yoga is commonly perceived and has become a very popular alternative medicine for its minimal expenditure and simplicity. Theoretical explanation of benefits attained by yoga was proposed by Streeter et al [6] wherein yoga reduces the allostatic load in stress response systems such that optimal homeostasis is restored. The reduced drive and GABAergic activity can be corrected by yoga practices resulting in betterment of many disease symptoms. Currently, limited studies are available depicting the resting heart rate variability in the long term and regular practice of yoga. Hence the present study was aimed at investigating resting heart rate variability in regular yoga practitioners compared with non-yoga practitioners.

Materials and methods

This cross-sectional study was conducted after getting approved by an Institutional Ethics Committee at Madras Medical College, Chennai (Approval No. 26082010). The study subjects were recruited based on their willingness and we obtained informed consent from all the subjects. In our study, a total of 60 male subjects were recruited and were divided into two groups.

**Group 1** (Yoga group): 30 male subjects, regular yoga practitioners

**Group 2** (Control group): 30 male subjects, non-yoga practitioners

**Inclusion criteria:**

- Group 1: 30 male subjects doing regular yoga for more than 3 years for 30-60 min/day for a minimum of 4 days/week from various yoga centers in Chennai
- Group 2: 30 male subjects, non-yoga practitioners were included
- Age group between 25-45 years

**Exclusion criteria:**

- Females were excluded from the study because of procedural constraints. Individuals with a history of procedural constraints. Individuals with a history of cardiovascular problems, renal disorders, pulmonary function problems, neuromuscular disorders, neurological problems, smoking and alcohol were excluded.
- The subjects were made comfortable.
- Free from stress without any significant anxiety and any recent illness.
- The subjects were tested after 10-30 minutes in a supine position when they were relaxed in resting conditions.
- Compressive garments were removed.
- Subjects were asked to be avoid on the day of testing any beverage containing caffeine, nicotine and alcohol.
- Vigorous exercise was asked to be avoided on the day before testing.
- HRV test was carried out between 10:00 AM – 10:30 AM i. e. 2-2½ hours after breakfast.
• Any other medications that could alter the blood pressure and heart rate were asked to be stopped ideally 24-48 hours before testing.

Parameters studied:
Mean HR, Mean RR, NN50, pNN50, LF power, HF power, LF (n.u), HF (n.u), LF/HF ratio.

Time-domain components consisted of mean HR, mean RR, standard deviation of RR intervals (SDNN), square root of the mean of the sum of the squares of differences between adjacent RR intervals (RMSSD), adjacent RR interval differing more than 50 ms (NN50), and NN50 counts divided by all the RR intervals (pNN50).

Frequency-domain components consisted of very low frequency (VLF) component (0.003 to 0.04 Hz), low-frequency (LF) component (0.04 to 0.15 Hz), and high-frequency (HF) component (0.15 to 0.5 Hz) and LF/HF ratio, low frequency power in normalized units (LF nu) = (LF x 100) / (TP–VLF), and similarly HF nu was calculated (HF nu) = (HF x 100) / (TP–VLF). HF, HF nu, SDNN, RMSSD, NN50, and pNN50 reflect cardiovagal tone; LF reflects both the sympathetic and parasympathetic tones; VLF component's interpretation is not clear, and it cannot be interpreted using short-term HRV recordings; LF nu and HF nu represent a relative tone of the sympathetic and parasympathetic nervous system.

Statistical analysis
All the data obtained was statistically analyzed using SPSS version 17 (SPSS Inc., Chicago, IL, USA). Comparison between the groups were done using independent sample 't' test. The p value of < 0.05 was taken as significant.

Results

Table 1: Comparison of between the groups

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control group</th>
<th>Yoga group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean HR</td>
<td>75.57±9.79</td>
<td>67.63±9.36</td>
<td>0.002</td>
</tr>
<tr>
<td>HF (n.u)</td>
<td>42.65±7.59</td>
<td>57.70±10.74</td>
<td>0.000</td>
</tr>
<tr>
<td>LF (n.u)</td>
<td>57.68±7.74</td>
<td>42.30±10.74</td>
<td>0.000</td>
</tr>
<tr>
<td>HF power</td>
<td>35.06±8.58</td>
<td>50.30±10.10</td>
<td>0.000</td>
</tr>
<tr>
<td>LF power</td>
<td>47.36±7.75</td>
<td>37.06±10.70</td>
<td>0.000</td>
</tr>
<tr>
<td>LF/HF ratio</td>
<td>1.44±0.44</td>
<td>0.80±0.40</td>
<td>0.000</td>
</tr>
<tr>
<td>Mean RR</td>
<td>0.81±0.10</td>
<td>1.08±0.37</td>
<td>0.000</td>
</tr>
<tr>
<td>NN50</td>
<td>67.10±41.92</td>
<td>106.83±44.63</td>
<td>0.001</td>
</tr>
<tr>
<td>pNN50</td>
<td>17.50±11.25</td>
<td>32.20±15.12</td>
<td>0.000</td>
</tr>
</tbody>
</table>

In the control group, an increase in the mean heart rate, LF and LF/HF ratio were found. There was a significant decrease in the HF components, which suggested a decrease in the parasympathetic activity and increased sympathetic activity in non – yoga practitioners (Table 1).

The HF (n.u), HF power, Mean RR, NN50 and pNN50 were significantly high in the yoga practitioners. This shows the predominance of parasympathetic activity in the yoga group (Table 1).

The mean HR was significantly (p=0.002) lower in regular yoga practitioners (67.63±9.36) when compared with non-yoga practitioners (75.57±9.79) (Figure 1).

![Figure 1: Mean heart rate (HR)](image)

There was a significantly (p=0.000) raised HF (n.u.) in regular yoga practitioners (57.70±10.74) when compared with non-yoga practitioners (42.65±7.59) (Figure 2). The LF (n.u.) was low in yoga group (42.30±10.74) when compared with control group (57.70±10.74) (Figure 2). Similarly, there was a significantly raised HF power in regular yoga practitioners (50.30±10.10) when compared with non-yoga practitioners (35.06±8.58) (Figure 2). Also LF power was significantly lower in yoga group compared to controls (Table 1, Figure 2).

The LF/HF ratio in regular yoga practitioners (0.80±0.40) when compared with non-yoga individuals (1.44 ±0.44) was significantly low (p=0.000) (Figure 3).

The mean RR interval in regular yoga practitioners (1.08±0.37) when compared with non-yoga practitioners (0.81±0.10) was higher (p=0.000) (Figure 4).

The average NN50 value in yoga group (106.83±44.63) was statistically higher than the control group (67.10±41.92) (Figure 5). Likewise the percentage of pNN50 in regular yoga practitioners (32.20±15.12) when compared with non-yoga practitioners (17.50±11.25) was significantly high (Figure 6).
**Figure 2**: High and low frequency components of HRV

**Figure 3**: LF to HF ratio of HRV

**Figure 4**: Mean RR interval

**Figure 5**: Differences in NN50

**Figure 6**: Differences in pNN50
Discussion

In recent years, as yoga became more popular and yoga classes became more accessible to the public in India, it is important to validate beliefs and confirm claims about yoga’s benefits. Currently, there is a scarcity of well-designed research addressing these specific claims. In the current climate of interest in Complementary and Alternative Medicine (CAM) and Wellness and Health Promotion, it is imperative to address the claims in a manner that does not ignore that yoga is meant to be practiced as a complete system.

There is an extensive literature documenting many determinants of autonomic tone [7]. The stress response is characterized by sympathetic activation, an initial stage which mobilizes the body by either fight-or-flight response, for immediate action. In this stage, the pituitary and hypothalamus sends signals to the sympathetic nervous system.

We come across many internal and external stressors in our daily routine, and if we do not succeed in overcoming it, we may become chronically stressed. Chronic stress leads to negative physical, mental and cognitive impact and also leads to anxiety and depression [8]. Studies show that chronic life stress and diseases are very closely associated [9]. Stress influences the hypothalamus via the limbic system and causes changes in the heart rate variability (HRV) through the autonomic nervous system. HRV may be used to evaluate the mental stress and to determine the status of the autonomic nervous system [10].

In the present study, there was significantly less mean heart rate accompanied with significantly higher mean RR interval in regular yoga practitioners compared with the non-yoga practitioners. This might be due to the calming effects of regular yoga. The practice of yoga provides advantage to many by creating beneficial physiological changes in bodily systems including the nervous system.

Khattab et al reported that relaxation by yoga after 5 weeks of training is associated with a significant increase of cardiac vagal modulation [11]. Another randomized control trial in Brazil reported significant decreases in LF as well as the LF/HF ratio following 4 months of respiratory yoga training [12]. In our study raised HF (n.u.) and HF power was observed in regular yoga practitioners compared with non-yoga practitioners. Also, a significantly lower LF (n.u.) and LF power was observed in regular yoga practitioners compared with non-yoga practitioners.

The LF/HF ratio is considered to emulate sympatho-vagal balance or to reflect sympathetic modulations. In the present study, there was a significantly lower LF/HF ratio in regular yoga practitioners which indicates that sympatho-vagal balance upon regular balance.

In our study there was a significant increase in the NN50 and pNN50 in regular yoga practitioners with a concomitant increase in HF power and HF (n.u.) indicating an increase in the parasympathetic activity after regular yoga training. Yoga practices increases HRV which is an indicator of a healthy autonomic tone.

Conclusion

This study concludes that parasympathetic dominance in regular yoga practitioners as evidenced by decreased heart rate, LF, LF/HF ratio and increased HF power, mean RR, NN50, PNN50. This indicates that there is increased parasympathetic activity and decreased sympathetic activity in regular yoga practitioners. There is increased resting heart rate variability (HRV) in them, which is a good indicator of cardiac autonomic activity during rest and the possibility of reducing cardiovascular disease risks in regular yoga practitioners.

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References


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