Original Article

Impact of short-term practice of yoga on heart rate variability

Vinay AV, Venkatesh D[1], Ambarish V[1]

Department of Physiology, PES Institute of Medical Science and Research, Kuppam, Andhra Pradesh, [1]Department of Physiology, M. S. Ramaiah Medical College, Bengaluru, Karnataka, India

Address for correspondence: Dr. Vinay AV, Department of Physiology, PES Institute of Medical Science and Research, Kuppam, Andhra Pradesh, India.
E-mail: av17vinay@gmail.com

ABSTRACT

Background: Yoga is a science that facilitates homeostasis, an ancient way of life intended to improve the quality of life of an individual. Practice of yoga is proposed to alter the autonomic nervous system and affect the cardiovascular functioning. This study was intended to assess the influence of short-term practice of yoga for a month on heart rate variability (HRV).

Materials and Methods: Totally, 40 healthy male volunteers in the age group of 30–60 years willing to practice yoga for a month were included in the study. HRV was assessed using HRV device (RMS Vagus, India). Preinterventional assessment of HRV was done in these subjects. Practice of yoga that included a set of physical postures (*asanas*), breathing techniques (*pranayama*), and meditation (*dhyana*) were performed for an hour daily for 1 month under the guidance of a certified yoga instructor. Postinterventional assessment of HRV was done. The values were expressed in median and their interquartile range, and statistical analysis was done to compare the changes using Wilcoxon Signed Rank Test.

Results: Thirty-two of 40 subjects recruited for yoga practice completed the study protocol. Analysis of HRV revealed that in time domain parameters, SDNN increased from 33.60 (31.41–44.82) to 42.11 (34.43–57.51), RMSSD increased from 22.00 (16.00–33.80) to 25.6 (17.0–34.8), and PNN50 increased from 2.45 (0.80–15.38) to 7.35 (1.40–18.57) after intervention. In the frequency domain parameters, the low-frequency (LF) power spectrum reduced from 39.30 (25.1–46.25) to 30.40 (22.75–40.62) and LF/high-frequency ratio was reduced from 2.62 (1.91–4.07) to 2.28 (1.4–3.07) after 1 month practice of yoga. $P < 0.05$ was considered statistically significant.

Conclusion: Autonomic balance tilts toward parasympathetic predominance after 1 month practice of yoga.

Key words: Autonomic function; heart rate variability; yoga.

INTRODUCTION

Yoga is a way of life aiming to promote healthy body and healthy mind.[1] It is a valuable gift of the Indian Vedic philosophy to the modern world. Yoga in Sanskrit means yoke or union.[1] Yoga aims at uniting individual self with the cosmic consciousness. This is achieved through physical postures (asanas), breathing techniques (pranayama), and meditation (dhyana).[1] Yoga is emerging as an important modifying factor for health and behavior to achieve better physical and mental well-being.

Access this article online	
Website: www.ijoy.org.in	Quick Response Code
DOI: 10.4103/0973-6131.171714	

The practice of asanas improves the muscle strength, mind-body coordination, and balance.[2] Further, it improves the blood flow, tissue perfusion and oxygenation, and enhancing functions at cellular level. Meditation and breathing technique calms down the mind, improves the concentration enhancing better work output. By maintaining tranquility of mind, it can promote clear thinking, better judgment, and effective decision making.[3] It also alters the autonomic balance to promote health.

How to cite this article: Vinay AV, Venkatesh D, Ambarish V. Impact of short-term practice of yoga on heart rate variability. Int J Yoga 2016;9:62-6.

Cardiovascular diseases are the leading cause of morbidity and mortality in developed and developing countries.[4] Autonomic imbalance with sympathetic overactivity leads to hypertension, arrhythmias, and metabolic dysfunction.

Heart rate variability (HRV) is a noninvasive tool for assessment of cardiac autonomic status. The decrease in HRV is a clinical predictor of mortality due to cardiac causes.[5] HRV is the temporal variation in consecutive heart beats measured from a standard electrocardiogram (ECG). R wave is the peak of QRS complex; the duration between two consecutive R wave peaks is termed the relative risk interval. It is also called NN intervals when the heart is beating at sinus rhythm. HRV is the measurement of the variability of the NN intervals. The assessment of this difference is performed in time domain and frequency domain. These parameters were used to assess cardiac autonomic control which is the balance between sympathetic and parasympathetic regulators of heart.[6] Reduced parasympathetic activity decreases the HRV. Reduced HRV is a potential risk factor for hypertension, thermogenesis which progress to Coronary artery disease.[7]

Stress is an integral and inevitable part of modern day life. Repeated exposure to episodes of stress or continuous exposure can have an adverse impact on health in general and cardiovascular function in particular. These undesired side effects of distress are modulated by alteration in sympathovagal balance. This can lead to reduced parasympathetic variability shifting to sympathetic predominance. These alterations in the autonomic functions allowed to continue over a period without intervention can lead to irreversible damage in cardiovascular functions.

Integration of yogic practice in day to day life can favorably impact the modifiable risk factors for cardiovascular diseases.

There are studies focusing on the effect of yoga on HRV in regular long-term practitioners. A study by Muralikrishnan *et al*. demonstrated well balanced vagal activity in practitioners of Isha yoga as compared to control group.[8] Increased parasympathetic modulation was demonstrated in healthy practitioners of yoga[4] by Khattab *et al*.

The present study was undertaken to assess the value of short-term practice of yoga and its impact on cardiac autonomic functions.

MATERIALS AND METHODS

The study was performed in Department of Physiology, M S Ramaiah Medical College, Bengaluru. The study protocol was approved by the Institutional Scientific and Ethics Committee.

Participants

Forty healthy male volunteers willing to practice yoga regularly for a month in the age group of 30–60 years.

Inclusion criterion

Healthy male volunteers with no previous experience of practice of yoga.

Exclusion criterion

Cardiovascular diseases, metabolic diseases, smokers, alcoholics, and on treatment with drug having potential to modify autonomic functions.

Study design

Prospective interventional study.

Assessment done

Pre- and post-interventional assessment of HRV using RMS vagus HRV device and software.

Intervention

Subjects were trained under the guidance of certified yoga instructor. Integrated yoga comprising 5 min of stretching exercises and prayer, 20 min of *asanas* (*padmasana, vajrasana, tadasana, vrikshasana, mathsyasana, paschimothasana, gomukhasana, bhujangasana)*, 20 min of *pranayama* (*Nadi shudhi pranayama, suryanadi pranayama, chandranadi pranayama, bhramari*), and 15 min of meditation and relaxation were practiced for an hour daily, 6 days a week for 1 month.

Data extraction and analysis

The recording protocol was explained, and informed consent was obtained from all the volunteers. Subjects were initially rested for 15 min. Then, the data were extracted in the form of Lead II ECG using RMS Vagus HRV apparatus (RMS, India) while subjects are resting in supine position with eyes open for duration of 15 min. This was done to make sure that subjects didn't sleep during the recording.

The extracted ECG data were manually scanned for any artifacts and only artifact free 15 min data were used for analysis. If there were any artifacts, the recordings were repeated on the next day.

The ECG was analyzed using RMS Vagus HRV software (RMS, India). The analysis from the HRV software provided information about time domain (SDNN, RMSSD, NN50, and PNN50) and frequency domain parameters (low-frequency [LF], high-frequency [HF], and LF/HF ratio).

The same protocol was followed for both pre- and post-interventional assessments.

Statistical analysis

The statistical analysis was done using SPSS for Windows, Version 16.0. Chicago, SPSS Inc. The pre- and post-intervention values of HRV were tabulated, and coefficient of variation was calculated to evaluate pattern of distribution. As all the values were skewed and were expressed as median and inter quartile range, nonparametric test was used to analyze data by Wilcoxan Signed Rank Test.

RESULTS

Forty male subjects satisfying the inclusion and exclusion criterion were recruited for the study. Thirty-two subjects successfully completed the protocol of yogic practice. The age of the subject was 45 ± 7.6 years and body mass index was 25.74 ± 3.78 kg/m^2. The pre- and post-interventional average heart rate in the subjects were 74.29 ± 11.34 beats/min and 73.56 ± 12.59 beats/min, respectively and were not statistically significant.

Comparison of heart rate variability parameters

The preinterventional value of SDNN was 33.60 (31.41–44.82) ms and postinterventional value was 42.11 (34.43–57.51) ms. The preinterventional value of RMSSD 22.0 (16.0–33.8) and postinterventional value was 25.6 (17.0–34.8). The preinterventional value of PNN50 2.45 (0.80–15.38) and postinterventional value was 7.35 (1.40–18.57). The postinterventional value of SDNN, RMSSD, and PNN50 was significantly higher ($P < 0.05$). The preinterventional value of NN50 was 28.5 (9.0–101.0) and postinterventional value was 65.0 (15.0–112.25). However, the difference was not statistically significant.

In the frequency domain, values were expressed in power percentage. Preinterventional value of LF in percentage was 39.30 (25.1–46.25) and postinterventional value was 30.40 (22.75–40.62). The preinterventional value of LF/HF ratio was 2.62 (1.91–4.07) and postinterventional value was 2.28 (1.4–3.07). The postinterventional value of LF and LF/HF ratio was significantly lower ($P < 0.05$). The preinterventional value of HF in percentage was 13.25 (8.02–20.0) and postinterventional value was 16.0 (8.30–23.07). HF showed an increasing trend but was not found to be statistically significant. The preinterventional value of very LF (VLF) in percentage was 44.0 (32.15–67.77) and postinterventional value was 47.9 (37.37–63.3). There was no significant change in VLF after 1 month of practice of yoga [Table 1].

DISCUSSION

Cardiovascular diseases are major cause of morbidity and mortality in the developing countries. Their incidence is on the rise and is contributory to major health burden of a country. The increasing trend of these diseases can be attributed to lifestyle changes, food habits, lack of physical exercise associated with mental stress, environmental pollution, increase susceptibility to infections, and habits such as smoking and consumption of alcohol.

There are number of risk factors for cardiovascular diseases, majority of them are modifiable. Precautionary steps taken well in advance will reduce the sufferings of an individual and health burden of the country.

Physical exercise in general and yoga, in particular, is reported to reduce the occurrence of cardiovascular diseases and possible complications arising out of them. Yoga is reported to promote physical and mental health by the performance of postures (*asanas*), regulated breathing (*Pranayama*), and meditation (*dhyana*).

There is a need to objectively evaluate the perceived or the reported benefits of yogic practice. There are different tools to quantify the benefits of yoga on cardiovascular system.

HRV is a potential tool for assessing the influence of autonomic nervous system on cardiovascular system. Autonomic disturbances can adversely impact the functioning of the heart. HRV can serve as a sensitive

Table 1: Effect of 1-month practice of yoga on HRV parameters

HRV parameters	Median (IQR)		*P*
	Preintervention	Postintervention	
SDNN (ms)	33.60 (31.41-44.82)	42.11 (34.43-57.51)	0.006**
RMSSD	22.00 (16.00-33.80)	25.6 (17.0-34.8)	0.007**
NN50	28.50 (9.00-101.00)	65.0 (15.0-112.25)	0.370
PNN50 (%)	02.45 (0.80-15.38)	7.35 (1.40-18.57)	0.004**
VLF (%)	44.0 (32.15-67.77)	47.9 (37.37-63.3)	0.400
LF (%)	39.30 (25.1-46.25)	30.40 (22.75-40.62)	0.049*
HF (%)	13.25 (8.02-20.0)	16.0 (8.30-23.07)	0.080
LF/HF	2.62 (1.91-4.07)	2.28 (1.4-3.07)	0.049*

*$P<0.05$; **$P<0.01$; HRV = Heart rate variability, IQR = Interquartile range, VLF = Very low-frequency, LF = Low-frequency, HF=High-frequency

method of evaluating the early changes in cardiac autonomic function.

In this study, the effect of short-term practice of yoga was evaluated on cardiac autonomic function. The time domain markers such as SDNN, RMSSD, and PNN50 were found to be significantly increased after practice of yoga for 1 month. These changes are attributed to shift of autonomic balance from the sympathetic nervous system to the parasympathetic system. SDNN indicates variability in duration of diastole which in turn influences the functioning ability of the heart. Increase in RMSSD and PNN50 suggests parasympathetic predominance evidenced by increased duration of cardiac cycle.[9]

Practice of yoga for a month significantly reduced LF power spectrum. This may be attributed to inhibition of posterior or sympathetic area of the hypothalamus which optimizes the body's sympathetic responses to stressful stimuli. This helps restore autonomic regulatory reflex mechanisms associated with stress.

LF/HF ratio, a marker of autonomic balance, was found to be significantly reduced suggesting the shift of autonomic balance toward parasympathetic predominance. Woodyard C has reported the beneficial effects of yoga such as reduced respiratory and heart rate, reduced blood pressure, low cortisol levels, increased blood flow to the intestines, and vital organs on practice of yoga due to increased parasympathetic activity.[10]

HF power spectrum showed an increasing trend on short-term practice of yoga. The reduction in LF/HF ratio in this study was likely to be predominantly by sympathetic withdrawal and to a limited extent by increasing parasympathetic activity. A study on long-term practice of yoga can help establish the relative contribution of sympathetic and parasympathetic system in autonomic modulation of cardiovascular system.

VLF, the nonneuronal component influencing HRV, did not show a significant change suggesting that the beneficial effect of yoga on the heart was predominantly mediated through neuronal mechanism involving autonomic nervous system.

There was a fall in average heart rate in subjects after intervention but was not statistically significant.

Taskforce of the European society of Cardiology and the North American society of Pacing and Electrophysiology describes HF as a representative of vagal modulation activity and LF as a representative of sympathetic or mixed sympathetic and vagal modulation activities.[6]

There is general opinion that the ratio between LF and HF components of HRV spectra (LF/HF ratio) represents a measure of balance of sympathovagal activity.[11] LF/HF ratio higher than 4.8 was considered to reflect predominant sympathetic and those lower than 1.3 predominant vagal modulation activity.[12] It can be comprehended that these parameters eventually modulate the heart rate.

By considering all the above facts, our study demonstrated a significant reduction in LF and an increasing trend in HF, suggesting need to include a control group in the study for effective comparison.

In view of significant reduction in LF/HF ratio and their resultant effect on heart rate, it can be concluded that short-term practice of yoga reduces sympathetic activity to greater extent than increasing parasympathetic activity.

The present study establishes the fact that HRV changes can be demonstrated after practice of yoga for a month. Time domain and frequency domain parameters exhibited a favorable change with short-term practice of yoga.

The regular practice of yoga is known to elevate mood and relieve the stress by increasing serotonin levels. It reduces monoamine oxidase which breaks down serotonin, thus maintaining serotonin for longer duration in the brain.[9] Practice of yoga increases blood flow, levels of oxygen saturation and improves oxygenation of the tissues.[9] Yoga also reduces viscosity of the blood which can decrease the risk of heart attack and stroke.[9]

A study by Bharshankar *et al*., Birkel and Edgren *et al*. reported low resting heart rate, increased endurance, improved maximum uptake, and utilization of oxygen during exercise in subjects practicing yoga.[13-15]

Practice of yoga for 8 weeks had bought about changes in frequency domain parameters along with significant decrease in LF and increase in HF value suggesting parasympathetic dominance. Our study has established changes in both time and frequency domain parameters indicating sympathetic withdrawal coupled with parasympathetic predominance.

Practice of yoga helps achieve emotional balance, inhibits the areas in amygdala responsible for fear, aggression and rage. It stimulates the reward or pleasure centers in the median forebrain and other areas leading to a state of bliss and pleasure. This in turn lowers anxiety, respiratory rate, heart rate, and blood pressure.[13,14,16,17] It is reasonable to postulate that the practice of yoga not only influences the autonomic balance at subconscious level but also controls this balance by regulating emotional changes.

In our study, there was a demonstrable improvement in the cardiac autonomic function. Yoga has a noticeable benefit on general health status of the individual and thus promoting positive health. These beneficial effects were observed even with short-term practice of yoga. It is reasonable to believe that regular and long-term practice of yoga will help reduce the incidence of noncommunicable diseases resulting in better quality of life.

Unbalanced sympathetic overactivity can lead to cardiovascular and metabolic disorders. These can lead to development of hypertension in later part of life. Practice of yoga which involves lifestyle modification can be used as a nonpharmacological technique to prevent cardiovascular complications.

Periodic assessment of cardiac autonomic function in subjects who have practiced yoga for short duration can be undertaken. These assessments will throw light on the sustenance of beneficial effects after cessation of yogic practice. However, it is worthwhile to recommend continued practice of yoga to preserve and enhance beneficial effects obtained by short-term practice of yoga.

CONCLUSION

In our study, influence of short-term practice of yoga for duration of 1 month in healthy male volunteers showed a demonstrable change in HRV, with a significant decrease in sympathetic activity and trend toward an increase in parasympathetic activity, hence shifting sympathovagal balance toward parasympathetic predominance.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Iyengar BK. Illustrated Light on Yoga. New Delhi: Harper Collins Publishers; 2005.
2. Borg-Oliver S, Machliss B. Applied Anatomy & Physiology of Yoga. 1st ed. New South Wales (Australia): Yoga Synergy Pty Limited; 2005.
3. Santaella DF, Devesa CR, Rojo MR, Amato MB, Drager LF, Casali KR, *et al.* Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: A randomised controlled trial. BMJ Open 2011;1:e000085.
4. Khattab K, Khattab AA, Ortak J, Richardt G, Bonnemeier H. Iyengar yoga increases cardiac parasympathetic nervous modulation among healthy yoga practitioners. Evid Based Complement Alternat Med 2007;4:511-7.
5. Majercak I. The use of heart rate variability in cardiology. Bratisl Lek Listy 2002;103:368-77.
6. Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J 1996;17:354-81.
7. Huikuri HV, Jokinen V, Syvänne M, Nieminen MS, Airaksinen KE, Ikäheimo MJ, *et al.* Heart rate variability and progression of coronary atherosclerosis. Arterioscler Thromb Vasc Biol 1999;19:1979-85.
8. Muralikrishnan K, Balakrishnan B, Balasubramanian K, Visnegarawla F. Measurement of the effect of Isha Yoga on cardiac autonomic nervous system using short-term heart rate variability. J Ayurveda Integr Med 2012;3:91-6.
9. McCall T. Yoga as Medicine: The Yogic Prescription for Health and Living. 1st ed. New York: Bantam Publishers; 2007.
10. Woodyard C. Exploring the therapeutic effects of yoga and its ability to increase quality of life. Int J Yoga 2011;4:49-54.
11. Malliani A, Pagani M, Lombardi F, Cerutti S. Cardiovascular neural regulation explored in the frequency domain. Circulation 1991;84:482-92.
12. Milicevic G. Low to high frequency ratio of heart rate variability spectra fails to describe sympatho-vagal balance in cardiac patients. Coll Antropol 2005;29:295-300.
13. Birkel DA, Edgren L. Hatha yoga: Improved vital capacity of college students. Altern Ther Health Med 2000;6:55-63.
14. Bharshankar JR, Bharshankar RN, Deshpande VN, Kaore SB, Gosavi GB. Effect of yoga on cardiovascular system in subjects above 40 years. Indian J Physiol Pharmacol 2003;47:202-6.
15. Harinath K, Malhotra AS, Pal K, Prasad R, Kumar R, Kain TC, *et al.* Effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion. J Altern Complement Med 2004;10:261-8.
16. Desikachar K, Bragdon L, Bossart C. The yoga of healing: Exploring yoga's holistic model for health and well-being. Int J Yoga Ther 2005;15:17-39.
17. Javnbakht M, Hejazi Kenari R, Ghasemi M. Effects of yoga on depression and anxiety of women. Complement Ther Clin Pract 2009;15:102-4.