DOI: 10.7860/JCDR/2014/7844.3983

Original Article

Physiology Section

Effect of Yoga Therapy on Heart Rate, Blood Pressure and Cardiac Autonomic Function in Heart Failure

BANDI HARI KRISHNA[1], PRAVATI PAL[2], PAL G.K.[3], BALACHANDER J.[4], JAYASETTIASEELON E.[5], SREEKANTH Y[6], SRIDHAR M.G.[7], GAUR G.S.[8]

ABSTRACT

Background and Objective: It is well known that a hall mark of heart failure is adverse changes in autonomic function. Elevated blood pressure is a powerful predictor of congestive heart failure and other Cardiovascular Disease (CVD) outcomes. In this study, we planned to examine the effects of a 12 week yoga therapy on blood pressure, heart rate, heart rate variability, and rate pressure product (RPP).

Methods: Out of 130 heart failure patients recruited for the study, 65 patients were randomly selected to receive 12 week yoga therapy along with standard medical therapy (yoga group). Other patients (n=65) received only standard medical therapy (control group). Heart rate, blood pressure, cardiac autonomic function (by short-term heart-rate variability analysis) and myocardial oxygen consumption (by RPP) were assessed before and after 12 weeks. In the yoga group, 44 patients and in the control group, 48 patients completed the study.

Results: There was a significant decrease in heart rate, blood pressure and RPP in yoga group compared to control group. Also, LFnu and LF-HF ratio decreased significantly and HFnu increased significantly in yoga group compared to control group.

Conclusion: Twelve-week yoga therapy significantly improved the parasympathetic activity and decreased the sympathetic activity in heart failure patients (NYHA I&II)

Keywords: Yoga, Cardiac failure, Heart rate variability

INTRODUCTION

Heart failure is one of the major chronic illnesses responsible for a huge clinical and economic burden all over the world [1]. Based on disease specific estimates of prevalence and incidence rates of heart failure, the prevalence of heart failure in India due to coronary artery diseases, hypertension, obesity, diabetes and rheumatic heart diseases range from 1.3 to 4.6 million, with an annual incidence of 4,91,600-1.8 million [2]. Despite recent advances in pharmacologic and device therapy, morbidity and mortality from heart failure remain high [3]. Heart failure is associated with altered autonomic function [4]. There is markedly elevated sympathetic activity for a prolonged period in heart failure. Though less well documented, parasympathetic withdrawal is also an important facet of heart failure [5]. Elevated blood pressure is a powerful predictor for congestive heart failure and other CVD outcomes [6-8].

Yoga is a mind-body technique, which combines set of physical exercises (asana) in sync with breathing techniques (pranayama), relaxation and meditation. Yoga techniques produce a variety of beneficial effects on CVD [9-11]. It has been reported that yoga results in an improvement in lipid profiles [10], heart rate variability [12], decrease in blood pressure [11], RPP [13] and even regression of atherosclerosis when combined with dietary and other lifestyle modifications [14,15]. However, most of these studies are limited by lack of controls and varied types, intensities, and durations of yoga protocols used, making it difficult to compare and interpret results for heart failure patients.

Hence, in this study, we planned to examine the effects of a 12 week yoga therapy on blood pressure (BP), heart rate (HR), heart rate variability (HRV), and RPP, since RPP is a measurable index of myocardial oxygen consumption and load on the heart [16].

METHODS

Following approval of the institute ethics committee, 130 heart failure patients were recruited from the cardiology outpatient department of Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry. Patients with systolic and/or diastolic dysfunction, having ejection fraction 30-50%, fulfilling New York Heart Association (NYHA) class I-II criteria, able to walk without assistance and maintaining stable health condition on medical therapy were included in the study. Patients having chronic obstructive pulmonary disease, unable to attend yoga sessions, with orthopedic impediments to yoga, who were hospitalized within last three months and who had myocardial Infarction or recurrent angina within last six months were excluded from the study.

Patients were randomly divided into two groups: 1. Control group (n=65), in which patients received standard medical therapy; 2. Yoga group (n=65), in which patients received 12 week yoga therapy along with standard medical therapy. However, 44 patients in yoga group and 48 patients in control group completed the study.

Yoga Protocol

Yoga sessions lasted for 60 minutes and were conducted thrice per week, for a total of 36 supervised sessions over 12 weeks. During each session, subjects practiced the following asanas and pranayama [Table/Fig-1].

Heart rate and blood pressure was recorded before and after each yoga session. Yoga sessions were conducted at ACYTER, JIPMER, by a yoga therapist with expertise in cardiac rehabilitation. Each session lasted around 60 minutes. After two weeks of participation in monitored sessions, they practiced the same for three days under direct supervision of the yoga therapist and three days at their home, for a total duration of three months.

Modifications were made on an individual basis, according to each participant's specific medical or orthopedic limitations. Chairs were used for those who were unable to stand up from the floor and the wall was used for support during the standing balance postures, as needed. Pranayama breathing exercises (breath awareness training) consisted of deep inhalation and exhalation in a 1:1 ratio, without breath retention. Inhalation was taught to begin with sequential involvement of the abdomen, lower chest, and then upper chest, with the same sequence in reverse, during exhalation. Meditation and relaxation practice was performed in a supine or seated position according to comfort level and participant's preference.

Sl. No.	Name of the Practice	Repetition	Duration (60 min) Approx
1	Loosening practices	1	10 min
2	Makarasana	1	2 min
3	Tadasana	2	2 min
4	Trikonasana	2	2 min
5	Veerasana	2	2 min
6	Ardhakati Chakrasana	2	2 min
7	Vakrasana	2	2 min
8	Matsysana	2	2 min
9	Makarasana	1	2 min
10	Meditation	1	10 min
11	Chandranadi Pranayama	10	5 min
12	Bhramari Pranayama	2	2 min
13	AUM chanting	4	2 min
14	Shavasana	1	15 min

[Table/Fig-1]: Yoga therapy protocol

Sl. No.	Total No of Patients (n=92)	Yoga Group (YG) (n =44)	Control Group (CG) (n=48)
1	Age (Years)	49.34 ± 5.70	50.14 ± 4.54
2	Men/Women, n (%)	32/12, (72.72%)/(27.27%)	32/16, (66.66%)/(33.33%)
3	Height (cm)	162.74 ± 8.03	163.24 ± 6.88
4	Weight (kg)	70.16 ± 8.24	70.46±6.71

[Table/Fig-2]: Patients baseline characteristics

Sl. no.	Parameter	Yoga Group (YG) n=44 Mean+SD		Control Group (CG) n=48 Mean+SD	
		Before	After	Before	After
1	HR (beats/ min)	96.36 ± 5.85	81.48 ± 7.07***	96.33 ± 5.43	92.04 ± 5.68**
2	SBP (mmHg)	140.59 ± 7.54	131.80 ± 4.93**	142.42 ± 8.37	139.75 ± 8.37**
3	DBP (mmHg)	98.23 ± 7.79	84.93 ± 4.80***	97.21 ± 5.88	94.08 ± 5.84***
4	RPP (HR*SBP)	13569.23 ± 1357.50	10742.07 ± 1069.18***	13723.71 ± 1219.67	12867.46 ± 1177.11***
5	LFnu	68.98 ± 12.77	30.314 ± 8.42***	70.406 ± 12.39	50.998 ± 9.42**
6	HFnu	31.01 ± 8.42	69.68 ± 8.42***	29.552 ± 12.43	49.048 ± 9.42**
7	TP (ms2)	659.93 ±4 69.40	605.66 ± 1080.92	737.21 ± 730.30	597.33 ± 601.76
8	LF/HF	3.38 ± 3.36	0.45 ± 0.16***	3.4945±3.54	1.1890 ± 86**

[Table/Fig-3]: Within group differences; ** P<0.01; ***P<0.001

Laboratory conditions and recording of Blood Pressure and HRV

All experiments were performed at the cardiac autonomic function research laboratory. Recording of Short-term HRV was done at 8.00 AM following 10 minutes of supine rest. The patients were asked to refrain from heavy physical activity for 24 hours and from consumption of alcohol and caffeinated beverages for 12 hours prior to the measurements. The temperature of the laboratory was kept between 25° C - 28° C and lights subdued. The patients were asked to void urine before testing and made to sit in the lab comfortably to accustom to the new environment. First heart rate and ascultatory blood pressure was measured after subject had been sitting quietly for 10 minutes. The mean of three consecutive measurements with a maximum variation of 4 mmHg of both systolic and diastolic blood pressures was accepted [17]. Then at supine rest with eyes closed and relaxed position, lead II ECG was acquired at the rate of 200 samples/second for 10 minutes with the normal breath rate of 12-18/ minute using Bioharness (USA), which is the data acquisition system.

Sl. no	Parameter	Yoga Group % Change from Baseline	Control Group % Change from Baseline	p-value versus Control
1	HR (Beats/min)	15.53 ± 3.34	4.43 ± 3.26	<0.001
2	SBP (mm of Hg)	6.12 ± 3.70	1.84 ± 2.34	<0.001
3	DBP (mm of Hg)	13.25 ± 5.22	2.13 ± 3.18	<0.001
4	RPP (HR*SBP)	20.73 ± 3.80	6.19 ± 3.82	<0.001
5	LFnu	63.15 ± 55.52	26.00 ± 14.68	<0.001
6	HFnu	–195.06 ± 202.35	–111.17 ± 160.72	<0.001
7	TP (ms2)	78.56 ± 42.92	118.27 ± 542.71	0.561
8	LF/HF	93.56 ± 79.13	51.88 ± 25.49	<0.001

[Table/Fig-4]: Between group differences

The recommendations of Task Force on HRV [18] were followed; an RR series was extracted from ECG using maximum amplitude and sharpness of the peaks for R wave detection. After exclusion of artifacts and ectopics, a stationary 256s RR series was chosen and analyzed with Kubios HRV Version 2.0 software for HRV (Bio-signal analysis Group, Finland). Mean RR was measured in milliseconds. The RR series was resampled at 4Hz, its mean and trend removed, a Hann window applied and the 1024 data-point series was transformed by Fast Fourier Transformation (FFT). Frequency domain indices such as total power (TP), normalized LF power (LFnu), normalized HF power (HFnu) and LF-HF ratio were calculated.

STATISTICAL ANALYSIS

Statistical analyses were performed using Statistical Package for Social Sciences 19 (IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.). Data is expressed as mean±SD. Student's paired 't' test was applied for parametric data and Mann-Whitney U-test was applied for non-parametric data to compare various parameters before and after intervention in yoga group and control group separately. To compare the percentage change from baseline between the yoga group and control group, we used Student's unpaired t-test.

RESULTS

The baseline characteristics of the subjects assigned to control group and yoga group are given in [Table/Fig-2].

In the yoga group, 12 weeks of yoga therapy resulted in a significant decrease in HR (p<0.001), RPP (p<0.001), systolic BP (p<0.01), diastolic BP (p<0.001), LFnu (p<0.001), LF/HF ratio (p<0.001) and a significant increase in HFnu (p<0.001). In the control group, when parameters were compared before and after 12 weeks, there was significant reduction in HR (p<0.01), RPP (p<0.001), systolic BP (p<0.01), diastolic BP (p<0.001), LFnu (p<0.01), LF/HF ratio (p<0.01) and a significant increase in HFnu (p<0.01) [Table/Fig-3].

However, when the changes before and after 12 weeks were expressed in percentage, HFnu was significantly increased and other parameters were significantly reduced in the yoga group compared to the control group (P<0.001) [Table/Fig-4].

DISCUSSION

Despite recent advances in medical management in heart failure, one-third of patients are admitted annually for exacerbation of symptoms of heart failure [19]. A significant relationship of persistently elevated systolic BP and its progression with incidence of heart failure was observed in a community based study on elderly population [20]. De Jong MJ reported decreased HRV in heart failure patients [4]. In the present study, we found that a 12 week yoga therapy comprising of asana and pranayama significantly reduced HR, systolic BP (SBP), diastolic BP (DBP), RPP, LF nu, LF/HF ratio and increased HFnu.

Mechanisms by which yoga might have influenced HR, BP, RPP and HRV in this study are speculative at this time. In addition to

hemodynamic derangements, an increased neuro-hormonal activation via the sympathetic nervous system and the renin-angiotensin system has been implicated in the progression of heart failure [21,22]. Indeed, drugs such as beta blockers and angiotensin-converting enzyme inhibitors/angiotensin-receptor blockers that block this neuro-hormonal activation lead to a reduction in morbidity and mortality in patients with congestive HF [23,24]. HR and BP are influenced by input from both the parasympathetic and the sympathetic systems [3]. The LFnu and LF/HF ratio of HRV represent sympathetic modulation and HFnu represents parasympathetic modulation. In our study, addition of yoga therapy to standard medical therapy resulted in a significant decrease in the HR, BP, LFnu, LF/HF ratio, and increase in HFnu component of HRV and thus, a shift towards parasympathetic predominance. In addition to the proposed mechanism of yoga's ability to attenuate the derangement of autonomic nervous system, its effect on BP may be beneficial as well. Studies of yoga treatment in hypertensive patients have demonstrated mean reduction of SBP and DBP of 10-15 mmHg [9,25]. In this study, we found that the yoga therapy group had 15.53% reduction in HR, 6.12% reduction in SBP, 13.25% reduction in DBP, whereas standard medical therapy group patients had 1.84% reduction in HR, 4.43% reduction in SBP, 2.13% reduction in DBP and the differences between the two groups were found to be highly significant. The RPP, an indicator of myocardial oxygen consumption and load on heart was significantly reduced (20.73% in yoga group and 6.19% in standard medical therapy group), which shows that yoga has a beneficial effect on the reduction of load on heart in heart failure patients.

CONCLUSION

In conclusion, the present study shows that yoga therapy in addition to standard medical therapy reduces blood pressure, load on heart and improves parasympathetic activity in heart failure patients.

Limitations and future perspectives

The sympathetic activity measured by HRV for heart failure is not adequate. Therefore, future studies should include more accurate methods of assessment of sympathetic activity such as estimation of plasma catecholamines or metabolites of catecholamines in urine like vanillylmandelic acid (VMA), metanephrine, and normetanephrine.

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PARTICULARS OF CONTRIBUTORS:
1. PhD scholar, Department of Physiology, JIPMER, Puducherry- 605006, India.
2. Professor, Department of Physiology, JIPMER, Puducherry-605006, India.
3. Professor & Head of Physiology & Programme Director, ACYTER, JIPMER, Puducherry, India.
4. Senior Professor of Cardiology, Medical Superintendent, JIPMER, Puducherry, India.
5. Senior Research Fellow, ACYTER, JIPMER, Puducherry, India.
6. Senior Resident, Department of Cardiology, JIPMER, Puducherry, India.
7. Senior Professor & Head of Biochemistry, JIPMER, Puducherry, India.
8. Additional Professor, Department of Physiology, JIPMER, Puducherry, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Pravati Pal,
Professor, Department of Physiology, JIPMER, Puducherry-605006, India.
Phone: 9360682406, E-mail: drpravatipal@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Oct 08, 2013**
Date of Peer Review: **Oct 20, 2013**
Date of Acceptance: **Dec 12, 2013**
Date of Publishing: **Jan 12, 2014**