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Original Scientific Paper

Autonomous Control of Cardiovascular Function in Yoga Instructors and Effects of Energetic Renewal on Modulation of Autonomic Function

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Abstract: *The purpose of this study was to assess existence of connection between the yoga practice and autonomic nervous system activity, i.e. connection between autonomic heart control and yoga practice, as well as influence of some yoga techniques (pranayama and shavasana) on autonomic modulation of cardiac function. Results of the research show that yoga practice contributes to the balance of sympathovagal relation and baroreflex balance. Energetic renewal – relaxation (shavasana) improves sympathovagal balance and baroreflex sensitivity.*

Key words: *yoga, heart rate varibility, energetic renewal with relaxation, meditation, autonomic nervous system.*

Introduction

Modern medicine began to show interest in the old practice of the ancient yogis.
Many scientific researches show that yoga can be recognized as adequate help in prevention as well as in management of asthma (Sathyaprabha, 2001), hypertention (Selvamuthy, 1998), anxiety (Ray , 2001) overcoming stress (Malathi, 1999). Researches point that yoga practice improves subjective well being (Ray, 2001) and long time practice influences changes in blood pressure and heart rate (Frumkin, 1978).

The aim of this study was to assess cardiac autonomic control in yoga teachers and to research the reasons for (non)existence of the effects of energetic renewal with *shavasana* (deep relaxation) on autonomic modulation of cardiac function.

Research

In this pilot study we included 10 healthy yoga instructors (3 men and 7 women, average age. 45.00 ± 10.32) and compared them to 10 perfectly healthy subjects who have never practiced yoga (3 men and 7 women ; average age 42.17 ± 11.19). All yoga instructors have been practicing yoga regularly for at least two years.
Standard cardiovascular reflex tests according to Ewing (Ewing, 1982, 1985, Baron, 1999) were performed in all yoga practitioners and controls. Blood pressure variability in response to hand-grip and orthostatic challenge reflected sympathetic activity.

Heart rate variability in response to standing up, deep breathing and Valsalva manouevre was an indicator of parasympathetic function.

Results of these tests were graded as normal (score 0), borderline (score 1) or abnormal (score 2). Overall autonomic dysfunction was expressed as a score on a ten-point scale.

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Short-term spectral analysis of heart rate variability was assessed using a 5-minute ECG recording with fast Fourier transformation. Low frequency (low frequency-LF од 0,04Hz до 0,15 Hz) and high frequency (high frequency – HF од 0,15 Hz до 0,5 Hz) power components were measured and expressed as absolute values (bmp^2/Hz) and as percent of total spectral power density (LF% and HF%). The LF/HF ratio was also calculated. Continuous real time beat-to-beat ECG signal monitoring with heart rate variability analysis at rest was used to measure the low and high frequency components expressed in normalized units (LFnu-RRI and HFnu-RRI) and LF/HF-RRI ratio.

Baroreflex sensitivity was calculated as the slope of regression between spontaneous sequences of blood pressure changes and simultaneously occurring variations of RR intervals (BRS) and expressed in ms/mmHg. Time domain parameters of heart rate variability (mean RR interval, standard deviation of all NN intervals -SDNN, standard deviation of the averages of NN intervals in all 5 minute segments-SDANN, mean of the standard deviations of all NN intervals for all 5 minute segments-SDNN index, the square root of the mean of the sum of squares of differences between adjacent NN intervals-rMSSD and number of pairs of adjacent NN intervals differing more than 50ms divided by the total number of all NN intervals-pNN50%) were derived from 24-hour ECG monitoring (Task Force)
Following these measurements, each of the yoga practitioners was instructed to breathe quietly for 5 minutes, then to start with zatrm circular breathing (7 udjai breathing cycle), and finally to perform energy recovery for 15 minutes.

Data obtained from yoga practicioners and control groups were tested for normal distribution by the Kolmorov-Smirnov test. Differences between groups were assessed by paired t-test, chi-square test and Mann-Whitney U-test.

The study was approved by the Ethical Committee of The School of Medicine, University of Belgrade and The Scientific Board of Clinical Center “Bezanijska Kosa”. Written consent was obtained from all subjects

Results

There were no statistical differences between groups in relation to age. (T-test, $p > 0.05$), and gender (χ^2 test, $p > 0.05$).
The results of Ewing`s battery of tests showed that there were no statistically significant differences between the yoga instructor and non instructor groups in relation to tests that reflect sympathetic activity (Table 1).
Similarly, there were no statistically significant differences between groups regarding parasympathetic activity (Table 2).

Table 1. Ewing`s cardiovascular reflex tests in yoga practitioners and controls (sympathetic function)

	Yoga practicioners	Controls	Statistical significance
Hand grip test			p > 0.05
Median (min-max)	2 (0 – 2)	2 (0 – 2)	
Orthostatic hypotension			p > 0.05
Median (min-max)	0 (0 – 1)	0 (0 – 1)	
Sympathetic dysfunction			p > 0.05
Median (min-max)	1 (0 – 1)	1 (0 – 1)	

min- minimal value, max-maximal value

Table 2. Ewing`s cardiovascular reflex tests in yoga practitioners and controls (parasympathetic function)

	Yoga practicioners	Controls	Statistical significance
Valsalva manouevre			
Median (min-max)	2 (0 – 2)	0 (0 – 2)	p > 0.05
Deep breathing test			
Median (min-max)	2 (0 – 2)	0.5 (0 – 2)	p > 0.05
Stand up test			
Median (min-max)	1 (0 – 2)	0.5 (0 – 1)	p > 0.05
Parasympathetic dysfunction			p > 0.05
Median (min-max)	1 (0 – 2)	0.5 (0 – 1)	

min- minimal value, max-maximal value

The overall autonomic dysfunction score was grater in yoga instructors (5.7 ± **X)** than in controls.(4.0 ± **X**), This difference was statistically significant (Chart 1)

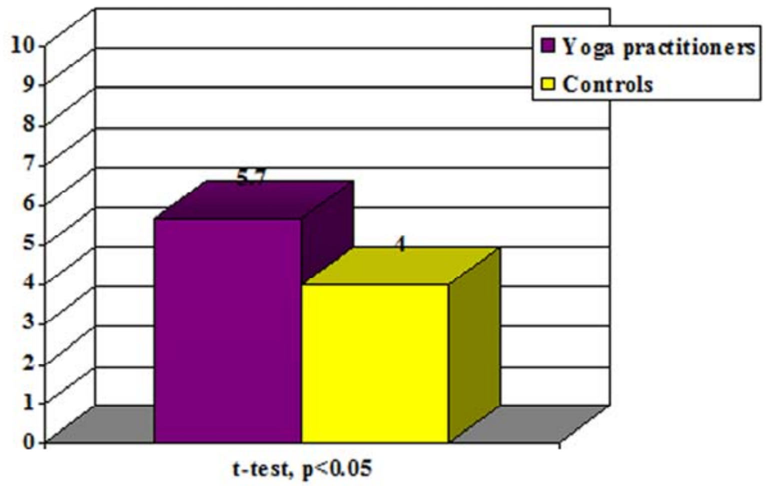


Chart 1. Overall autonomic dysfunction

Short-term spectral analysis of heart rate variability showed no significant differences of tested parameters between the two groups. (Table 3)

Table 3. Parameters of Short-term spectral analysis of heart rate variability

	Yoga practicioners	Controls	Statistical significance
LF (bpm^2/Hz)			
Median (min-max)	95.0(9.0-1557.0)	110.5 (8.0-417.0)	p> 0.05
HF (bpm^2/Hz)			
Median (min-max)	53.0 (20- 396.0)	43.0 (18.0-157.0)	p> 0.05
LF%			
Mean±SD	40.4 ± 22.2	33.4 ± 20.1	p> 0.05
HF%			
Mean±SD	16.6 ± 8.2	13.6 ± 6.0	p> 0.05

LF/HF index in yoga practitioners was lower than in the control group, but this difference was not significant. (Chart 2)

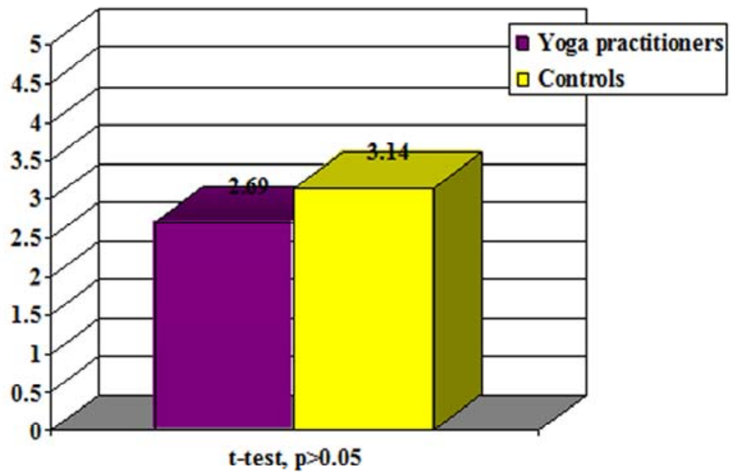


Chart 2. LF/HF index in yoga practitioners and controls

Continous real-time beat to beat ECG signal monitoring with heart rate variability analysis at rest showed no significant differences in relation to LFnu-RRI and HFnu-RRI values. The LF/HF-RRI ratio was also not significantly different between the groups. (Table 4)

Table 4. Real time beat-to-beat ECG signal monitoring with heart rate variability analysis and baroreflex function analysis

	Yoga practicioners	Controls	Statistical significance
LFnu-RRI			
Mean±SD	73.4 ± 14.8	58.3 ± 14.8	p > 0.05
HFnu-RRI			
Mean±SD	26.6 ± 13.1	39.2 ± 13.5	P > 0.05
LF/HF-RRI			
Median (min-max)	3.4 (1.4-42.8)	2.29 (0.9-7.1)	p> 0.05

SD-standard deviation, min-minimal value, max-maximal value

Baroreflex sensitivity was higher in yoga practitioner group compared to controls, but that difference was not statistically significant. (p>0.05) (Chart 3).

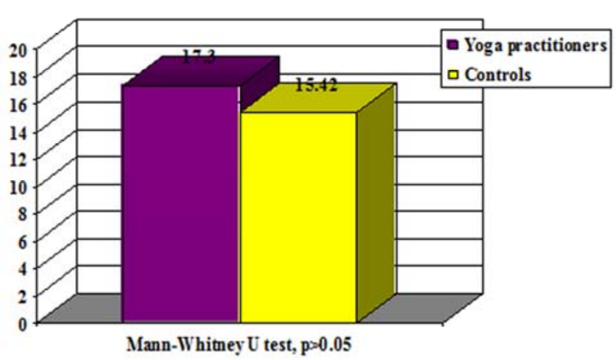


Chart 3. Baroreflex re sensitivity in yoga practitioners and controls

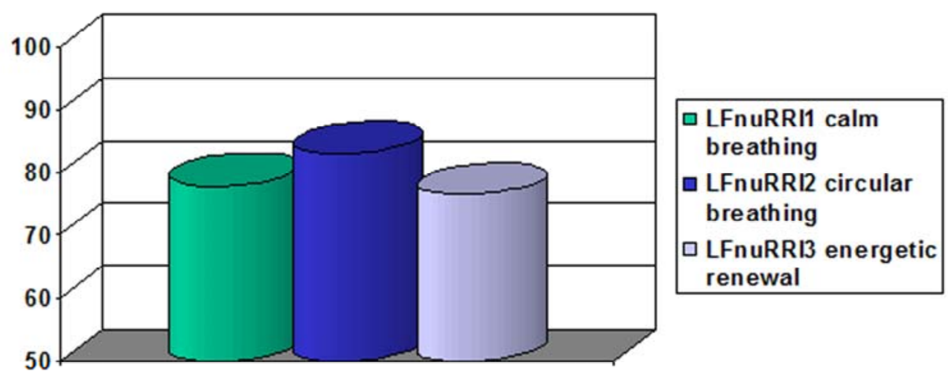
Time domain parameters of heart rate variability in yoga practicioners were not significantly different than in the control group.(Table 5)

Table 5. Time domain heart rate variability parameters (24 h holter monitoring)

	Yoga practicioner	Controls	Statistical significance
RR interval (ms)			p >0.05
Mean±SD	814.9 ± 67.3	806.4 ± 40.2	
SDNN/24h (ms)			p >0.05
Mean±SD	157.9 ± 40.1	164.0 ± 42.9	
SDANN index(ms)			p >0.05
Mean±SD	150.7 ± 39.6	144.0 ± 44.1	
SDNN index (ms)			p >0.05
Mean±SD	65.4 ± 20.8	53.0 ± 19.2	
rMSSD (ms)			p >0.05
Mean±SD	36.2 ± 15.0	26.3 ± 15.8	
pNN50 (%)			p >0.05
Median (min-max)	12.0 (0.0-32.0)	9.0 (3.0-24.0)	

SD-standard deviation, min-minimal value, max-maximal value

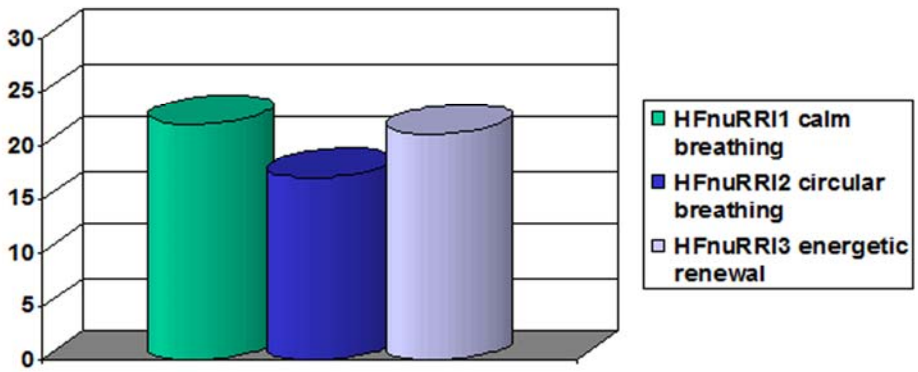
Also, there was a statistically significant difference between LFnu-RRI measurement during quiet breathing (LFnu RRI-1) in comparison to the circular breathing (breath udyai) (LFnu RRI-2) in the group of yoga instructors. (Chart 4)



< 0.05

Chart 4. LFnu-RRI during calm, circular breathing and energy renewal

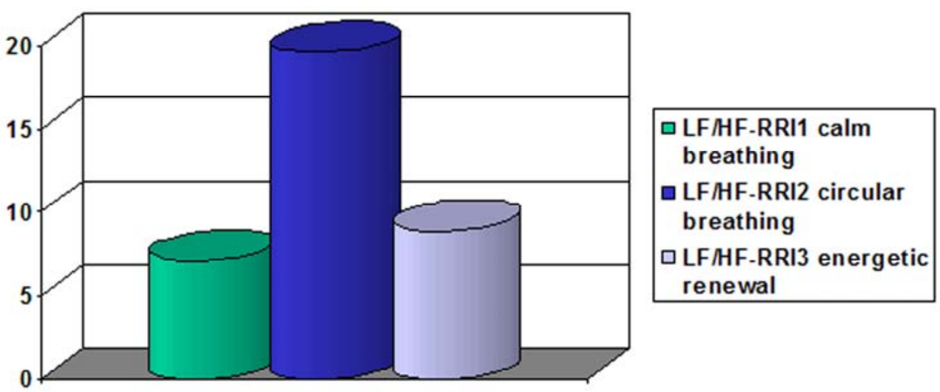
In contrast, there was a statistically significant reduction in RRI during HFnu-circular breathing over a period of calm breathing. (Chart 5)



< 0.05

Chart 5. HFnu-RRI, calm, circular breathing and energy renewal

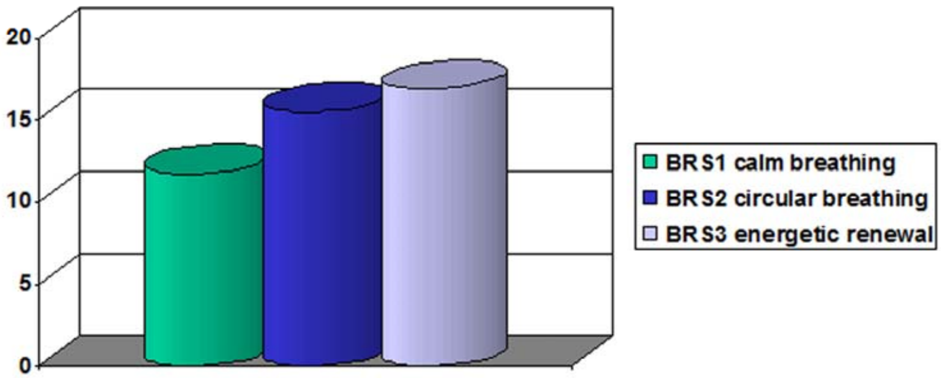
In addition, there was a statistically significant increment of LF / HF-RRI during circular breathing (LF / HF-RRI 1) in respect to periods of calm breathing (LF / HF-RRI 2) and energetic renewal (LF / HF-RRI 3). (Chart 6)



< 0.05

Chart 6. LF / HF-RRI during calm, circular breathing and energy renewal

Baroreflex sensitivity was significantly higher during the energy renawal period, compared to the calm and circular breathing periods. (Chart 7)



< 0.05

Chart 7. Baroreflex sensitivity during calm, circular breathing and energy renewal

Discussion

It is known that the autonomic nervous system plays an essential role in the modulation of cardiovascular function (Malathi, 1999). Balanced sympathetic and parasympathetic activity is crucial for adequate control of heart rate, excitability and contractility, as well as for the reflex short-term blood pressure regulation (Ray, 1999). Sympathetic nervous system facilitates outbreak at the sinoatrial node and thus increases heart rate frequency, atrioventricular conduction, excitability of the heart conduction system and cardiac muscle contractility. In contrast, the parasympathetic system exhibits inhibitory effects on the heart.

Our study did not show statistically significant differences between yoga practitioners and controls in relation to scores of sympathetic and parasympathetic dysfunction on Ewing`s tests. Moreover, the yoga group exhibited a significantly higher score of overall autonomic dysfunction. This fact can be explained by a small sample size.

However, short term spectral analysis of heart rate variability showed lower LF and higher HF values in the yoga group as expected. The LF/HF ratio was lower in the yoga group. Furthermore, real time beat to beat ECG signal and blood pressure monitoring showed greater baroreflex sensitivity at rest in yoga practitioners. These differences, although not statistically significant on our sample size, indicate enhanced parasympathetic modulation of heart rate variability and better sympathovagal balance in yoga practitioners. Baroreceptor sensitivity is essential for efficient parasympathetic modulation of heart rate. Similar results were shown by Hyorin et al. In addition, it was suggested that practicing yoga techniques shifts ANS function towards parasympathetic dominance (Patil, 2006).

An even more striking finding were differences observed within the yoga group in relation to heart rate variability, sympathovagal balance and baroreflex sensitivity during calm breathing, circular breathing and energetic renewal periods. We demonstrated a significant increase of LFnu-RRI and LF/HF-RRI and a significant decrease of HFnu-RRI immediately after the circular breathing period, indicating strong responsiveness of the sympathetic branch of ANS in yoga practitioners. Conversely, a nearly significant decrease of LFnu-RRI and LF/HF-RRI and increase of HFnu-RRI was observed immediately after the energetic renewal period. These results suggest that energetic renewal increases parasympathetic activity and sympathetic withdrawal. Moreover, baroreflex sensitivity increased throughout the whole period of real time ECG signal and blood pressure minitoring, and was significantly higher after the period of energetic renewal in relation to the calm breathing period. Similar results have been obtained by other investigators. Thus, Selvamurthy et al have reported that yogic training produces a significant decrease in BP associated with improvement of baroreflex sensitivity and attenuation of sympathetic activity (Selvamuthy, 1998).

Gobel et al found a significant reduction in rate pressure product in myocardial oxygen consumption and load on the heart and postulated a decrease in sympathetic drive to the heart as the underlying mechanism (Gobel, 1978)

Vijayalakshmi et al suggested that the vasoconstrictor and cardiac acceleratory responses to hand grip test are abnormal in hypertensive patients and that yoga training improves these reflex regulatory mechanisms.(Vijayalakshmi, 2004) Breathing techniques (*Pranayama*) may provide psycho physiological benefits by increasing the patient's sense of control over stress and thus aid the reduction of their autonomic arousal factors.

Conclusion

Yoga practice can be multiple significant for people's health. It is known that yoga has a great influence on activity of endocrine and imune system. Yoga stabilizes autonomic equilibrium with a tendency towards parasympathetic dominance rather than stress-induced sympathetic dominance. Yoga therapy readjusts autonomic balance, controls the rate of breathing and relaxes the voluntary inspiratory and expiratory muscles, resulting in decreased sympathetic reactivity. (Ram, 2003) Yoga increases respiratory efficiency, balances activity of opposing muscle groups and slows dynamic and static movements.

Conducted pilot study clearly demonstrated that practice of yoga, breathing techniques (*pranayama*) and energetic renewal in *shavasana* significantly influence sympathovagal balance and baroreflex sensitivity. Circular breathing and udyai breath was shown to result in augmentation of sympathetic activity. In contrast, energetic renewal was shown to be an excellent method for decreasing sympathetic activity, with the conscious control of our mind. Therefore, this study confirms previously suggested impact of yoga practice on cardiac autonomic function, and delineates the specific roles of different yoga techniques. Our further work with larger series of patients and controls is expected to yield more data on this issue with more precise statistical evidence and possibility of wider application of the studies yoga techniques.

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