Indian J Physiol Pharmacol 2004; 48 (1) : 59–64

MODULATION OF STRESS INDUCED BY ISOMETRIC HANDGRIP TEST IN HYPERTENSIVE PATIENTS FOLLOWING YOGIC RELAXATION TRAINING

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(Received on February 15, 2003)

Abstract : 13 essential hypertensive patients aged 41 to 60 years were given yoga training for 60 min daily, Monday through Saturday, for a total duration of 4 weeks. Blood pressure and heart rate (HR) were measured with non-invasive semi-automatic blood pressure monitor. Measurements were recorded before the training and at weekly intervals during the 4 week training period. Results of our study show a significant ($P<0.001$) reduction in resting HR and rate-pressure-product (RPP) after 2 weeks of yoga training. Systolic pressure (SP), diastolic pressure (DP) ($P<0.001$) and mean pressure (MP) ($P<0.05$) showed a significant reduction at 3 weeks of training period. After 4 weeks of training, there was further fall in SP, DP, pulse pressure (PP) ($P<0.05$), MP ($P<0.001$), HR and RPP. Isometric handgrip test before yoga training produced a significant rise in SP and MP and insignificant rise in DP, HR and RPP. After yoga training, there was a significant rise in all these parameters. Our results show that yoga training optimises the sympathetic response to stressful stimuli like isometric handgrip test and restores the autonomic regulatory reflex mechanisms in hypertensive patients.

Key words : yoga training blood pressure heart rate rate-pressure-product isometric handgrip

INTRODUCTION

Modern man has become a victim of daily stress and stress related disorders like essential hypertension, angina, insomnia and impotency. Being holistic in their approach, yogic techniques are ideal for improving one's ability to withstand stressful stimuli. There is evidence that yoga is effective for prevention as well as management of bronchial asthma (1), stress due to exams (2), anxiety and depression (3), stress in hypertensive patients (4) and in the cure/control of essential hypertension (5). Yoga is also known to improve the subjective well being (3, 6). Non-pharmacological control of essential hypertension with relaxation methodologies

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in the form of yoga (7, 8, 9), transcendental meditation (10) and progressive muscular relaxation (11) has become more popular recently, though these techniques have been practised in the past (12). Most of these techniques produce long-lasting changes in the blood pressure (BP) and heart rate (HR) if they are practised regularly (8, 12). Earlier studies by Selvamurthy et al (5) have shown that some yogic postural exercises can control essential hypertension. Many references are available on non-pharmacological control of essential hypertension (11, 13, 14) and a number of workers have used *shavasan* and other yogic techniques for the control of essential hypertension (7, 15, 16).

Rate-pressure-product (RPP) is a reliable index of myocardial oxygen consumption and cardiac work and it correlates well with the myocardial oxygen consumption of normal subjects as well as patients with angina pectoris (17). Yogasans may influence RPP by altering pre-load and or after-load. However, there is paucity of literature on the effect of yogasans on RPP in essential hypertension. In view of this, the present work was planned to study the effect of yoga training on BP, HR and RPP. Since vascular reactivity response can readily be detected by isometric stress (18), we extended our work to study the cardiovascular response to stress with isometric hand-grip (IHG) test before and after yoga training.

METHODS

Thirteen male patients attending JIPMER staff clinic for essential hypertension volunteered to be subjects for this study. All the patients were having uncomplicated essential hypertension for 3 to 17 (6.84 ± 1.39 SEM) years and were under treatment with Atenolol. Their age was 41 to 60 (50 ± 1.84 SEM) years, height 160 to 170 (163.84 ± 1.01 SEM) cm and weight 62 to 76 (71.07 ± 1.13 SEM) kg. After explaining purpose and design of the study, informed consent was obtained from them. They were taught yogasans and pranayams and practised the same under our direct supervision daily for one hour, Monday through Saturday for a total duration of four weeks. The yogasans and pranayams taught were :

Asans : *naukasan, vipareetakarani, matsyasan, shashasan, shavasan with kayakriya*

Pranayams : *pranava, chandra anuloma and savitri pranayams.*

Basal recordings were taken in sitting posture after 10 min of rest in a chair. Systolic pressure (SP), diastolic pressure (DP), mean pressure (MP) and HR were recorded by non-invasive semi-automatic blood pressure monitor (Press-Mate 8800, Colin Corporation, Japan). Pulse pressure (PP = SP-DP) and RPP ($RPP=HR \times SP \times 10^{-2}$) were calculated. HR and BP response to isometric handgrip was determined by asking the subject to sustain the handgrip for 2–3 min using partially inflated sphygmomanometer cuff so as to maintain the mercury column at a level corresponding to 1/3 of maximum voluntary contraction pressure (19). In our pilot study we found that our hypertensive patients could maintain the handgrip for 2–3 min as compared to 3–4 min in normal young subjects. Hence in the present study the duration of isometric handgrip exercise was kept at 2–3 min.

HR and BP were recorded before the yoga training and at weekly intervals during the four week training period. The response to IHG test was measured before and at the end of four week study period. Results were expressed as mean ± SEM. Data were analysed by repeated measures analysis of variance (ANOVA), followed by Tukey-Krammer multiple comparison test. Students paired 't' test was used to compare the parameters after the handgrip exercise and resting values and also for percentage (delta) changes before and after yoga training. For all comparisons, $P<0.05$ was considered statistically significant.

RESULTS

SP showed an insignificant increase in the 1st week, after which it decreased progressively. This decrease was statistically significant at 3rd and 4th week of the training period ($P<0.001$). DP also showed a marginal increase in the 1st week and a subsequent progressive decrease. This decrease was statistically significant at 3rd and 4th week ($P<0.001$). PP decreased significantly at 4th week ($P<0.05$). MP increased insignificantly at 1st week after which it decreased progressively, the decrease being statistically significant at 3rd and 4th week ($P<0.05$ and $P<0.001$ respectively). An insignificant decrease in HR was found at 1st week. Subsequently it showed progressive and statistically significant ($P<0.001$) decrease at 2nd, 3rd and 4th week. The pattern of changes in RPP was similar to that of the HR (Table I).

TABLE I: Systolic pressure (SP), diastolic (DP), pulse pressure (PP), mean pressure (MP), heart rate (HR) and rate-pressure product (RPP) before yoga training (control) and at 1, 2, 3 and 4th week of the training. Data are expressed as mean ± SEM. Results of post-hoc test (Tukey-Kramer multiple comparison test) are given in the footnote.

Parameter	*Control*	*1st week*	*2nd week*	*3rd week*	*4th week*	*F ratio*	*P value*
SP (mm Hg)	141.69±3.42	145.15±3.51	136.69±2.29	127.92±3.72	120.69±2.28	27.50	<0.0001
DP (mm Hg)	87.85±1.58	88.31±1.63	82.46±1.62	77.92±2.30	75.77±2.24	13.62	<0.0001
PP (mm Hg)	53.85±3.55	56.85±2.59	54.23±2.71	50.00±3.07	44.92±3.00	5.29	<0.0001
MP (mm Hg)	105.23±2.54	109.62±2.31	101.31±1.60	97.15±2.96	92.77±2.21	11.47	<0.0001
HR (bpm)	84.38±3.51	79.15±3.87	73.15±3.16	73.54±3.01	74.23±3.04	9.15	<0.0001
RPP (units)	119.77±6.23	115.57±7.52	99.90±4.42	94.04±4.75	89.40±3.69	18.47	<0.0001

Comparison	**P value**	**Comparison**	**P value**
SP: control Vs 3rd' week	<0.001	MP: control Vs 3rd week	<0.05
SP: control Vs 4th week	<0.001	MP: control Vs 4th week	<0.001
SP: 1st week Vs 2nd week	<0.05	MP: 1st week Vs 2nd week	<0.05
SP: 1st week Vs 3rd week	<0.001	MP: 1st week Vs 3rd week	<0.001
SP: 1st week Vs 4th week	<0.001	MP: 1st week Vs 4th week	<0.001
SP: 2nd week Vs 3rd week	<0.05	MP: 2nd week Vs 4th week	<0.05
SP: 2nd week Vs 4th week	<0.001	HR: control Vs 2nd week	<0.001
DP: control Vs 3rd week	<0.001	HR: control Vs 3rd week	<0.001
DP: control Vs 4th week	<0.001	HR: control Vs 4th week	<0.001
DP: 1st week Vs 3rd week	<0.001	RPP: control Vs 2nd week	<0.001
DP: 1st week Vs 4th week	<0.001	RPP: control Vs 3rd week	<0.001
DP: 2nd week Vs 4th week	<0.05	RPP: control Vs 4th week	<0.001
PP: control Vs 4th week	<0.05	RPP: 1st week Vs 2nd week	<0.01
PP: 1st week Vs 4th week	<0.01	RPP: 1st week Vs 3rd week	<0.001
PP: 2nd week Vs 4th week	<0.05	RPP: 1st week Vs 4th week	<0.001

For all other comparisons, $P>0.05$.

TABLE II: Cardiovascular response to isometric handgrip (IHG) test before and after yoga training for 4 weeks.

	Before yoga training			*After yoga training*		
Parameter	*Rest*	*IHG*	*% change*	*Rest*	*IHG*	*% change*
SP (mm Hg)	141.69±3.42	160.46±7.90*	13.12±4.87	120.69±2.28	145.00±4.40****	20.08±2.93
DP (mm Hg)	87.85±1.58	95.69±5.93	8.68±6.24	75.77±2.24	93.15±3.64***	24.32±6.00
PP (mm Hg)	53.85±3.55	64.77±5.06	26.52±12.09	44.92±3.00	53.54±2.98	24.50±8.66
MP (mm Hg)	105.23±2.54	131.46±4.78****	24.91±3.63	92.77±2.21	118.69±2.95****	28.42±3.78*
HR (bpm)	84.38±3.51	90.46±3.92	8.84±5.77	74.23±3.04	87.00±3.78**	18.33±5.07
RPP (units)	119.77±6.23	147.11±11.68	24.95±10.78	89.40±3.69	126.44±7.14**	42.51±7.57

SP: systolic pressure; DP: diastolic pressure; PP: pulse pressure; MP: mean pressure; HR: heart rate; RPP: rate pressure product.
Values are means ± SEM for 13 subjects.
*P<0.05, **P<0.02, ***P<0.01, ****P<0.001 compared to the rest value.

Before yoga training IHG test produced an increase in all the parameters mentioned above. However, the increase was significant in SP and MP (P<0.05 and P<0.001 respectively) (Table II). After four week yoga training, IHG test produced more pronounced and statistically significant increase in all the parameters. The percentage (delta) changes in the parameters before and after yoga training were found insignificant.

DISCUSSION

In the present study, we have recorded time course of the effect of yoga training on BP and HR in essential hypertensive patients. The marginal and insignificant increase in BP at the end of the first week is likely to be due to adjustment of the subjects to the study environment. From second week onwards there was a significant and progressive decrease in HR and RPP and from 3rd week onwards in SP, DP and MP as well. Our results are in agreement with the findings of Patel and North (16) who have reported that six weeks treatment with yoga relaxation produces a significant reduction in BP. Sunder et al (7) also have demonstrated that shavasan therapy results in statistically significant fall in both mean systolic and diastolic pressures as well as requirement of anti-hypertensive drugs. *Shavasan* is known to produce psychosomatic relaxation. In an earlier work from our laboratories, we have demonstrated that *shavasan* produces a consistent and significant reduction in oxygen consumption and this is associated with a feeling of psychosomatic relaxation (20). Stress reduction with behavioural procedures like yoga is known to benefit hypertensive patients by lowering their BP (13). Bera et al (21) also have reported that the effects of stress are reversed in significantly shorter time in *shavasan.* Blackwell et al (10) have also demonstrated that transcendental meditation reduces anxiety level and blood pressure. Malathi and Damodaran have demonstrated the beneficial role of yoga in not only causing reduction in basal anxiety level but also attenuating the increase in anxiety score in stressful states like examination (2). The early and significant reduction in BP and HR in our subjects might be due to our

training schedule consisting of *shavasan* as well as relaxing postures (*asans*) and breathing exercises (*pranayams*). A significant reduction in RPP indicates a decrease in myocardial oxygen consumption and load on heart (17). This can be explained on the basis of decrease in sympathetic drive to the heart. Our findings are consistent with those of Selvamurthy et al (5) who have reported that yogic training produces a significant decrease in BP associated with improvement of baroreflex sensitivity and attenuation of sympathetic and renin-angiotensin activity.

IHG test provides pressor stimuli to cardiovascular system through efferent sympathetic pathways with a resultant increase in HR and BP (19). BP response to IHG in our study is in agreement with the observation of other workers who have reported a rise in BP with IHG in essential hypertensive patients (22, 23). A blunted BP response to IHG may be due to insufficient sympathetic response in our hypertensive patients. Normally, IHG test increases DP by 16 mm Hg or more and a rise of 10 mm Hg or less indicates abnormal cardiovascular reflex regulation (24). In our subjects, IHG test increased the mean DP by 8 mm Hg and HR by 6 beats/min before yoga training. Both these changes were insufficient and statistically insignificant. After yoga training, HR as well as DP increased significantly in response to IHG test. Here, it is interesting to note that Selvamurthy et al have concluded that yoga training results in an improvement of baroreflex sensitivity (5). Our results are different from earlier studies reporting that sympathetic reactivity is reduced following yoga training (25) and the pressor response to emotional and physical stimuli becomes less exaggerated and less protracted after yoga training (4). Our results suggest that the vasoconstrictor and cardiac acceleratory responses to IHG test are subnormal in hypertensive patients and yoga training improves these reflex regulatory mechanisms. This is an interesting observation and needs further study and confirmation.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the Central Council for Research in Yoga and Naturopathy (CCRYN) and Director, JIPMER, Pondicherry, for funding the Research Project.

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