Indian J Physiol Pharmacol 2004; 48 (4): 461–465

MODULATION OF CARDIOVASCULAR RESPONSE TO EXERCISE BY YOGA TRAINING

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(Received on July 1, 2004)

Abstract : This study reports the effects of yoga training on cardiovascular response to exercise and the time course of recovery after the exercise. Cardiovascular response to exercise was determined by Harvard step test using a platform of 45 cm height. The subjects were asked to step up and down the platform at a rate of 30/min for a total duration of 5 min or until fatigue, whichever was earlier. Heart rate (HR) and blood pressure response to exercise were measured in supine position before exercise and at 1, 2, 3, 4, 5, 7 and 10 minutes after the exercise. Rate-pressure product [RPP = (HR × SP)/100] and double product (Do P = HR × MP), which are indices of work done by the heart were also calculated. Exercise produced a significant increase in HR, systolic pressure, RPP & DoP and a significant decrease in diastolic pressure. After two months of yoga training, exercise-induced changes in these parameters were significantly reduced. It is concluded that after yoga training a given level of exercise leads to a milder cardiovascular response, suggesting better exercise tolerance.

Key words : yoga training Harvard step test
rate-pressure product double product

INTRODUCTION

Yogic techniques are known to improve one's overall performance and work capacity. Following the study of Bhattacharya & Krishnaswami (1) in which they observed that yoga exercises do not produce marked effect on physical and physiological performance, there have been several reports on the beneficial effects of yoga training on physiological functions. Muralidhara & Ranganathan (2) have reported an improvement in cardiac recovery index after 10 week yoga training programme. Raju et al (3) have found a significant increase in maximal work output and a significant increase in oxygen consumption per unit work after yoga training. Bera & Rajapurkar (4) have reported a significant improvement in cardiovascular endurance and anaerobic power as a result of yoga training. However,

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Balasubramanian & Pansare (5) have reported that yoga training produces a significant decrease in anaerobic power. Exercise stress testing is a valuable tool for evaluating physical fitness and cardio-respiratory status. The effect of physical training on exercise tolerance is well known. However, there are limited studies on the effect of yoga training on cardiovascular response to stress. Moreover, there is paucity of information on the effect of yoga training on the time course of the cardiovascular response following exercise. In view of this, the present study was planned with the objective of determining the effect of yoga training on the cardiovascular response to step test and its time course after the exercise in normal young volunteers.

METHODS

Twenty one normal boys (age : 17–19 years) were recruited for the present study. Those having a history of active sports training or yoga practice, medical illness such as tuberculosis, hypertension, diabetes mellitus, bronchial asthma or major surgery in the recent past were excluded from the study. After explaining the design and purpose of the study, informed consent was obtained from them. Clearance was obtained from Institute Ethical Committee.

A few days before actual recording, the subjects were familiarized with the laboratory environment and experimental procedure. On the day of the test, the subjects reported at our laboratory in the morning, two hours after a light breakfast. The laboratory temperature was maintained at 27 ± 1°C. After 15 minutes of supine rest, heart rate (HR) and right brachial blood pressure (BP) was recorded with non-invasive semi-automatic blood pressure monitor using the oscillometric method (Press-Mate BP 8800, Colin Corporation, Japan). Pulse pressure (PP = SP – DP), mean pressure (MP = DP + PP/3) and rate-pressure product [RPP = (HR × SP)/100] and double product (Do P = HR × MP) were calculated for each recording. Three BP recordings at one-minute intervals were taken and the lowest of these values was included for calculation. Cardiovascular response to exercise was determined by Harvard step test using a platform of 45 cm height (6). The subjects were asked to step up and down the platform at a rate of 30/min for a total duration of 5 min or until fatigue, whichever was earlier. HR and BP response to exercise was measured in supine position before exercise and at 1, 2, 3, 4, 5, 7 and 10 minutes after the exercise.

The subjects were taught *yogasans* and *pranayams* for two weeks. Then they practised the same under our direct supervision, daily for 45 minutes, for a total duration of 2 months. The *yogasans* and *pranayams* taught were: *talasan, utkatasan, trikonasan, ardha-matsyendrasan, bakasan, pavanmuktasan, navasan, noukasan, matsyasan, pashchimottanasan, halasan, bhujangasan, shalabhasan, sarvangasan, shavasan, mukh-bhastrika, mahat-yoga pranayam, nadi shuddhi* and *savitri pranayam.*

The cardiovascular response to exercise was measured before the training and again at the end of the 2 months of study period. The data was analysed using Student's paired 't' test to compare the pre and post-training values. A p value of less than 0.05 was accepted as indicating significant difference between the compared values.

RESULTS

Results are given in Table I. Yoga

TABLE I: Effect of yoga training on cardiovascular response to exercise and post – exercise recovery.

	HR (beats/min)		*SP (mmHg)*		*DP (mmHg)*		*PP (mmHg)*		*MP (mmHg)*		*RPP (units)*		*Do P (units)*	
	Before	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
Basal	71.33 ± 1.11	65.71 ± 1.13**	116.14 ± 1.27	113.19 ± 1.34**	68.76 ± 0.97	62.57 ± 1.02***	47.38 ± 1.29	47.86 ± 1.04	84.19 ± 0.90	78.24 ± 0.94***	82.62 ± 1.84	71.48 ± 1.34***	6010.67 ± 123.78	5147.52 ± 120.20***
After step test														
1 min	141.67 ± 2.47‡	116.19 ± 2.46***‡	168.43 ± 2.52‡	151.14 ± 2.62***‡	61.43 ± 0.95‡	59.90 ± 1.06*†	107.00 ± 2.37‡	90.95 ± 2.67‡	96.76 ± 1.20‡	89.81 ± 1.27‡	238.19 ± 5.92‡	175.14 ± 4.62***‡	13729.52 ± 349.3‡	10445.43 ± 278.05***‡
2 min	118.38 ± 1.83	105.67 ± 1.66***	156.57 ± 2.54	143.10 ± 2.29***	61.62 ± 0.81	57.81 ± 0.83**	92.95 ± 2.91	85.29 ± 2.76*	92.14 ± 1.42	85.90 ± 0.71***	184.43 ± 5.27	150.95 ± 3.47***	10941.43 ± 310.22	9079.71 ± 166.11***
3 min	110.29 ± 2.33	102.14 ± 1.49**	146.00 ± 2.66	134.38 ± 1.57***	62.19 ± 0.92	58.19 ± 0.66***	82.95 ± 2.47	75.90 ± 1.69**	89.50 ± 0.63	83.10 ± 0.70***	161.24 ± 5.92	136.86 ± 2.83***	9922.76 ± 341.43	8492.38 ± 157.14***
4 min	107.81 ± 1.90	100.00 ± 1.62**	138.00 ± 2.98	129.62 ± 1.58*	60.19 ± 1.43	58.95 ± 0.55	77.81 ± 2.66	70.67 ± 1.66*	85.67 ± 1.64	82.10 ± 0.64*	149.05 ± 5.37	129.29 ± 2.81**	9268.76 ± 304.38	8217.10 ± 166.31**
5 min	105.90 ± 1.89	99.19 ± 1.78**	132.57 ± 2.47	122.38 ± 1.52***	62.38 ± 1.07	62.10 ± 0.56	70.19 ± 2.06	60.29 ± 1.54***	85.43 ± 1.32	81.95 ± 0.66*	140.62 ± 4.86	121.19 ± 2.97**	9082.05 ± 281.71	8133.10 ± 169.22**
7 min	103.00 ± 1.58	96.00 ± 1.43***	125.24 ± 2.08	115.14 ± 1.52***	64.95 ± 0.64	62.67 ± 0.89	60.29 ± 1.71	52.48 ± 1.55**	84.76 ± 1.04	79.76 ± 0.90***	129.10 ± 3.82	110.24 ± 2.56***	8753.67 ± 223.39	7669.81 ± 169.51***
10 min	101.57 ± 1.65‡	92.57 ± 1.45***‡	120.00 ± 1.47‡	110.95 ± 1.02***	67.24 ± 0.56+	63.43 ± 0.83***	52.76 ± 1.28†	47.52 ± 0.98**	84.48 ± 0.74	78.81 ± 0.76***	121.62 ± 3.06‡	102.43 ± 2.17***‡	8594.14 ± 192.3‡	7310.10 ± 165.86***‡

Basal: before step test; Before: before yoga training; After: after yoga training; HR: heart rate; SP: systolic pressure; DP: diastolic pressure; PP: pulse pressure; MP: mean pressure; RPP: rate-pressure product; Do P: double product.

Values are expressed as mean ± SEM for 21 subjects.

*P<0.05; **P<0.01; ***P<0.001 by paired 't' test between pre and post training values.

+P<0.05; †P<0.01; ‡P<0.001 by paired 't' test between basal and post-exercise values.

training produced a significant reduction in basal HR, SP, DP, MP, RPP and Do P. Before yoga training, step test produced a marked and significant rise in all these parameters except DP which showed a significant decrease following the exercise. All these parameters showed subsequent progressive recovery throughout the ten minute study period. After 2 months of yoga training, the exercise-induced change in these parameters was significantly less as compared to their pre-training response. Before yoga training, only MP returned to pre-exercise basal value whereas other parameters continued to be significantly different from their basal values at the end of 10 min post-exercise period. After yoga training, in addition to MP, SP, DP and PP also returned to their pre-exercise basal values by the end of 10 min study period.

DISCUSSION

The purpose of this study was to determine if yoga training modulates the cardiovascular response to exercise and its time course after the exercise. Yoga training for two months resulted in a significant decrease in basal HR and BP. Calculated RPP and Do P also decreased significantly. Since RPP is an index of myocardial oxygen consumption and load on the heart (7), our results indicate that after yoga training, a given level of exercise is less taxing for the heart. A decrease in DP after yoga training has also been reported by Ray et al (8) who attributed this to a reduction in sympathetic activity. Exercise produced a marked and significant increase in the parameters measured except DP which showed a significant decrease in response to exercise stress. After yoga training, these exercise-induced changes (i.e. decrease in DP and increase in other parameters) were significantly reduced. It is interesting to note that before yoga training only MP had returned to pre-exercise value at the end of 10 minutes study period. After yoga training, SP, DP and PP also returned to the pre-exercise basal values indicating faster recovery of cariovascular parameters after yoga training. Our results are similar to the recent findings of O' Sullivan and Bell (9) who have reported that physical training blunts the pressor, tachycardiac and vasodilator responses and attributed this to blunting of sympathetic vasodilator activation. Although Bhattacharya & Krishnaswami (1) concluded that yoga training does not produce any marked effect on the physiological parameters of the subjects, there are several reports of beneficial effects of yoga training on physiological functions. Bera & Rajapurkar (4) have reported that yoga training results in significant improvement in cardiovascular endurance and anaerobic threshold. This is consistent with the findings of Muralidhara & Ranganathan (2) that yoga training improves physical efficiency as indicated by significant increase in cardiac recovery index measured by Harvard step test. Our findings of lesser increase in BP, HR and RPP after yoga training are consistent with the findings of Ray et al (8, 10) that yoga training increases muscular endurance, delays onset of fatigue and enables one to perform work at lesser V_{O2} max. Palatini (11) has reported that in comparison to normotensives, the increase in DP in response to isometric exercise is substantially more in hypertensives. An exaggerated cardiovascular reactivity to the stressors is known to be a risk factor for

cardiovascular diseases whereas reduced reactivity is an indicator of fitness. Therefore a reduction in exercise-induced stress on cardiovascular system by yoga training has physiological significance as well as clinical applications.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support from the Director, Central Council for Research in Yoga & Naturopathy (CCRYN), New Delhi.

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CORRIGENDUM

Letter to the Editor: "Effect of six weeks of Shavasan training on spectral measures of short-term heart rate variability in young healthy volunteers." Volume 48: 3; line 8, 2004:

(1) Page 371, Column 2, para 3, line 8, please read P = 0.23 instead of P = 0.023.

(2) Page 371, Column 2, para 3, line 11, please read P = 0.35 instead of P = 0.035.