EFFECT OF YOGA TYPE BREATHING ON HEART RATE AND CARDIAC AXIS OF NORMAL SUBJECTS

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Summary : Effect of inspiratory and expiratory phases of normal quiet breathing, deep breathing and *savitri pranayam* type breathing on heart rate and mean ventricular QRS axis was investigated in young, healthy untrained subjects. *Pranayam* type breathing produced significant cardio-acceleration and increase in QRS axis during the inspiratory phase as compared to eupnea. On the other hand, expiratory effort during *pranayam* type breathing did not produce any significant change in heart rate or QRS axis. The changes in heart rate and QRS axis during the inspiratory and expiratory phases of *pranayam* type breathing were similar to the changes observed during the corresponding phases of deep breathing.

Key words : *Savitri pranayam* type breathing deep breathing cardiac axis heart rate

INTRODUCTION

Yogic techniques produce consistent physiological changes and have sound scientific basis (4, 12, 19, 20). There are a few reports on the effects of various *pranayams* i.e. *Yoga* breathing techniques on body functions (10, 15, 16, 17). Earlier, we have reported on the physiological effects of *savitri pranayam* which is done by breathing rhythmically, deeply and slowly at a very low respiratory rate (8). It was observed that this type of breathing (at a mean respiratory rate of 1.7 and 2.7 cycles per minute in two groups of subjects) produces an increase in heart rate (HR) although the tachcyardia was not statistically significant (14). However, the effect of breathing on

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HR is complex (6) and the HR response during inspiratory phase of *savitri pranayam* could be different from that during expiratory phase. Although the HR response to deep breathing has been studied by earlier workers (11, 13), the effect of *pranayam* type breathing on HR has not received much attention. Moreover, the effects of *pranayam* breathing on cardiac axis has not been reported so far. Hence, the present work was planned to study the changes in HR and mean ventricular QRS axis (cardiac axis) during inspiratory and expiratory phases of *savitri pranayam* type breathing in untrained subjects and to compare these changes with those occuring during deep breathing.

MATERIAL AND METHODS

The present study was conducted on 20 normal student volunteers aged 17-19 years. None of the subjects was trained in *yoga*. They were given instruction about the technique of *savitri pranayam* (8) which consists of four phases : *purak* (inspiration), *kumbhak* (held in breath), *rechak* (expiration), and *shunyak* (held out breath) with a ratio of 2 : 1 : 2 : 1 between these phases, Total duration of a cycle and hence the respiratory rate is an individual matter as long as the subject maintains the ratio. Using a 4 *tal* (multiplication factor) our subjects practised the *pranayam* with a count of 8 : 4 : 8 : 4 (8) and a respiratory rate of 2.5-4 per min. For deep breathing, the subjects were asked to maintain a rate of 6 deep breaths per minute (5 sec in, 5 sec out) with the help of a metronome. During *pranayam* type breathing as well as deep breathing, the subjects were asked to breathe deeply to their full capacity. The subjects practised the techniques of breathing for a day or two and reported for the study two hours after a light breakfast. Hence, this study was conducted on untrained subjects. Respiratory cycles (using a stethograph and Grass PT 5 transducer) and lead I and II of electrocardiogram were recorded simultaneously on Grass model 7 polygraph at paper speeds of 25 mm/sec and 5 mm/sec. Recordings were taken in supine posture in a quiet room (temp : 20$\pm$0.5°C) during (i) normal quiet breathing (eupnea), (ii) deep breathing and (iii) *savitri pranayam* type breathing in that order (Fig. 1), each phase lasting for 3 min. HR was calculated from R-R interval of the electrocardiogram. Cardiac axis was calculated from the hexaxial referral system.

For all the three types of breathing, measurements were taken while the subject was breathing according to that breathing pattern. During eupnea, HR and cardiac axis were measured at 3 min after the start of breathing. During deep breathing as well as *pranayam* type breathing, HR was measured at the start of breathing and at 3 min whereas cardiac axis was measured at 3 min after the start of breathing.

The data was evaluated statistically using Student's 't' test. Inspiratory and expiratory values during deep breathing and *pranayam* type breathing were compared respectively with inspiratory and expiratory values during eupnea.

RESULTS

The results are given in Fig. 1 and Table I. During eupnea, the respiratory rate was 12-20 (mean 16) breaths per minute. During deep breathing, the respiratory rate was maintained at a rate of 6 breaths per minute except in one subject who breathed at a faster rate. During *savitri pranayam* type breathing, the respiratory rate was 2.5-4 (mean 3.3) per min. During eupnea, the inspiratory HR was insignificantly higher than the

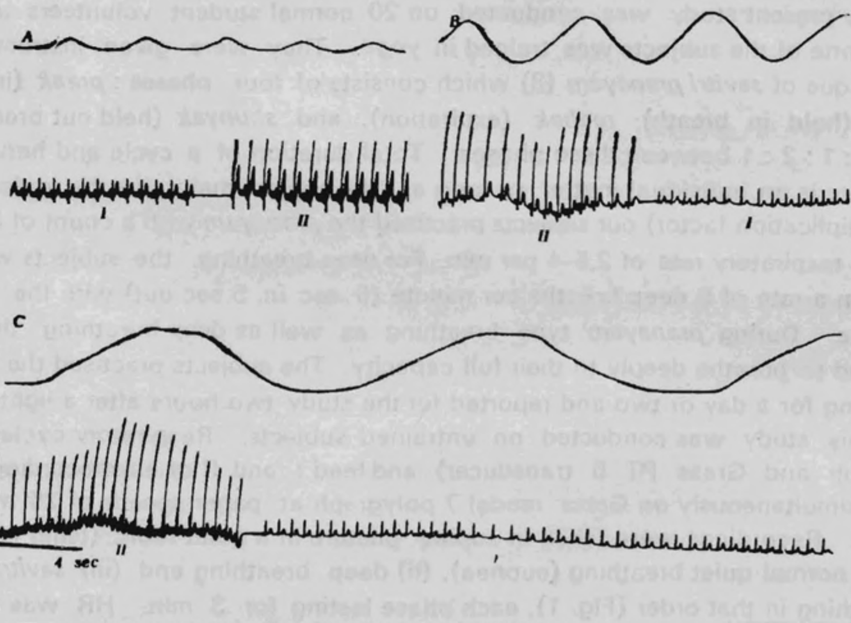

Fig. 1 : Respiratory pattern (Upper tracings) ang ECG (Lower tracings) during normal quiet breathing(A) deep breathing(B) and *Savitri pranayam* type breathing(C). Paper speed : 5 mm/sec.

expiratory HR, the mean difference being 6.89 beats per minute. Cardiac axis was insignificantly higher by 1.91° during the inspiratory phase of eupnea. During deep breathing, the inspiratory HR was higher as compared to normal quiet inspiration, the mean increase being 16.66 ($P < 0.05$) and 18.22 ($P < 0.005$) at the start of breathing and 3 min later. During the expiratory phase of deep breathing, HR was insignificantly less as compared to the normal quiet expiration, mean decrease being 2.56 and 1.11 beats per minute at the start of breathing and 3 min later. The value of cardiac axis during inspiratory phase of deep breathing was higher than that during normal quite inspiration by 9.35° (P < 0.005). During the expiratory phase of deep breathing, cradiac axis was insignificantly higher by 2.75° when compared to normal quiet expiration. During *pranayam* type breathing, inspiratory HR was higher by 14.77 and 13.71 at the start of breathing and 3 min later when compared to the HR during normal quiet inspiration, the increase being statistically significant (P < 0.05 and < 0.02 respectively). However, during the expiratory phase of *pranayam* type breathing, HR was very close to the value during normal quiet expiration. During the inspiratory phase of *pranayam* type breathing, cardiac axis was higher by 7.94° (P < 0.01) when compared to the axis during normal quiet inspiration. But during expiratory phase of the *pranayam*, cardiac axis was insignificantly less by 1.12° as compared to the axis during normal quiet expiration.

TABLE I : Heart rate and mean ventricular QRS axis during normal quiet breathing, deep breathing and *savitri pranayam* type breathing.

	NORMAL BREATHING (RR : 12-20)		*DEEP BREATHING (RR : 6)*				*PRANAYAM TYPE BREATHING (RR : 2.5-4)*			
	Inspiration	*Expiration*	*Inspiration*		*Expiration*		*Inspiration*		*Expiration*	
			Start of breathing	*3 min later*	*Start of breathing*	*3 min later*	*Start of breathing*	*3 min later*	*Start of breathing*	*3 min later*
Heart rate	82.67 ±3.94	75.78 ±3.96	98.33 ±5.53	100.89 ±3.98	73.22 ±4.85	74.67 ±3.27	97.44 ±5.34	96.38 ±3.41	76.22 ±6.78	75.00 ±4.38
P value		NS	<0.05	<0.005	NS	NS	<0.05	<0.02	NS	NS
QRS axis	70.64 ±1.69	68.73 ±1.42		79.99 ±1.34		71.48 ±2.56		78.58 ±1.60		67.61 ±5.01
P value		NS		<0.005		NS		<0.01		NS

Each value is mean ± SEM of 20 observations on 20 subjects.
RR = Respiratory rate per minute.

DISCUSSION

During eupnea the inspiratory HR was consistently higher than the expiratory HR, the mean difference being 6.89 beats/min. This HR variation between inspiratory and expiratory phases became more pronounced during deep breathing, increasing to 26 beats per minute. In an earlier study, Kanatsuka *et al.* (11) have reported a HR variation of 19.7 beats per min during deep breathing. This difference in HR variation of the two studies might be due to difference in age of the subjects and/or difference in the depth of breathing. The present study was conducted with the subjects in supine posture and Bellavere and Ewing (3) have reported that there is an increased vagal activity with augmented sinus arrhythmia in supine posture. During *pranayam* type breathing, our subjects showed a mean HR variation of 21 beats per minute between inspiratory and expiratory phases while breathing at a respiratory rate of 2.5-4 breaths per min. In a previous study, Angelone and Coulter (1) have shown that respiratory sinus arrhythmia in humans depends on breathing frequency in the range between 1 and 40 breaths per minute. The cardioacceleration during inspiration and deceleration during expiration is associated with a change in the efferent vagal discharge (vagal tone) to sinoatrial node (5,6). Hence HR variation during breathing depends on intact vagus (6,7) and is lost in vagal neuropathy (11,13). Fluctuations in efferent sympathetic activity also play a role in sinus arrhythmia (6). The impulses for this respiratory HR reflex arise from (i) stretch receptors located in lungs/thoracic wall (ii) medullary inspiratory center or (iii) right heart volume receptors (5,6). During deep breathing as well as *pranayam* type breathing, our subjects were breathing deeply and to their full capacity. Such a deep breathing in supine posture can result in an increased venous return with consequent distension of right heart and contribute to the cardioacceleration through the operation of Bainbridge reflex (6). The value of inspiratory HR during *pranayam* type breathing was close to the inspiratory HR during deep breathing and the mechanism(s) involved in cardio-acceleration are likely to be the same in deep breathing as well as *pranayam* type breathing.

In an earlier report, Angelone and Coulter (2) have demonstrated an inverse relationship between HR and held lung volume. Furthermore, Song *et al.* (18) have shown that during breath holding, HR is less at higher lung volumes and more negative intra-esophageal pressures. However, we did not observe any bradycardia during deep breathing or *pranayam* type of breathing. During the expiratory phase of both types of breathing, the HR was not significantly different from normal quiet expiration. This suggests that the vagal tone does not change significantly during deep expiratory effort as compared to that of eupnea. In a previous study (14), we have found an insignificant increase in HR (mean increase : 7.7/min) during *savitri pranayam* breathing. But in the present study, HR increased significantly by 14 beats per min during the inspiratory phase of *pranayam* type breathing. This apparent discrepancy can be ascribed to the fact that the HR was measured by counting for one minute irrespective of the inspiratory or expiratory phase of *pranayam* in our previous study (14). On the other hand the present study was designed to record the HR changes separately during the inspiratory and expiratory phases and we found a significant increase in the inspiratory HR with practically no change in the expiratory HR.

Mean cardiac axis during normal quiet inspiration was insignificantly higher than normal quiet expiration suggesting that the axis does not change significantly during eupnea. During the inspiratory phases of deep breathing as well as *pranayam* type breathing, cardiac axis was significantly more as compared to normal quiet inspiration. However, during their expiratory phases, cardiac axis did not change significantly. Anatomical position of heart is a major factor determining the mean QRS axis (9). Deep inspiration produces a distinct descent of diaphragm which is expected to produce a vertical shift of the heart. Hence the change in cardiac axis during inspiratory phases of deep breathing and *pranayam* type breathing can be explained on the basis of change in vertical orientation of heart as a result of diaphragmatic descent.

Our study has shown a significant cardioacceleration and vertical shift of cardiac axis during the inspiratory phase of *savitri pranayam* type breathing. The pattern of these changes was similar at the start of breathing and 3 min later and was comparable to the changes observed during the inspiratory phase of deep breathing. HR response to deep breathing is a simple, non-invasive and sensitive test to evaluate the degree of autonomic damage (7, 11, 13). *Savitri pranayam* type breathing may also prove useful as a bedside test for quantitative evaluation of autonomic neuropathy. Furthermore, it may be of interest to study if training in *yogic asans* or *pranayam* can alter the pattern of these responses.

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