© The Yoga Review Vol. III, No. 1, 1983

Cardiorespiratory changes during Savitri Pranayam and Shavasan

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Abstract :—The present study was conducted in trained (n=7) and untrained (n=7) volunteers to determine the effect of savitri pranayam and shavasan on O_2 consumption, heart rate and blood pressure. In trained subjects we found a consistent and significant ($p<0.01$) reduction in O_2 consumption within a few minutes of starting savitri pranayam. During shavasan, there was significant reduction in O_2 consumption ($p<0.05$), heart rate ($p<0.001$) and diastolic blood pressure ($p<0.05$). In untrained subjects, the changes in above mentioned parameters were statistically insignificant.

I. Introduction

For thousands of years, yogis of India have claimed that anyone can achieve unusual powers (Vivekanand Swami, 1975) and highly evolved physiological, emotional and spiritual levels by regular and persevering practice of yoga. Yogic methods which aim at physical and mental self-culture include pranayams (breathing techniques), asans (isometric postures) and meditation. These techniques produce consistent physiological changes and have sound scientific basis (Akishige, 1968; Kasamatsu and Hirai, 1966; Udupa and Singh, 1972;

Wallace, 1970). Yogis are capable of remarkable feats of endurance (Vakil, 1950) and control of their autonomic functions (Chhina, 1974). There is some evidence that yoga improves cardiorespiratory efficiency (Gopal *et. al.*, 1973; Udupa and Singh, 1972), produces psychosomatic relaxation (Gopal et al, 1974), helps in development of resistance against stress (Udupa and Singh, 1972) and keeps one in a better frame (Pathak *et. al.*, 1978). The efficacy of yoga in the management of hypertension (Datey *et. al.*, 1969; Patel and North, 1975), bronchial asthma (Wilson et al, 1975), sex related problems (Sharma and Sharma, 1973) and drug addiction (Benson, 1969) has been reported. These studies indicate that yoga, which is being practised in India since ancient times, has health promoting as well as therapeutic effect. Moreover it is free from the deleterious effects of drug therapy. Thus, yoga holds a great promise for the modern man who has become victim of everyday stress.

Inspite of practical applications of various techniques of yoga, scientific research on their physiological basis has been negligible. There are a few reports about the effects of various pranayams on body functions (Gopal *et. al.*, 1973; Miles, 1964; Rao, 1968). But so far the cardiovascular effects of *savitri pranayam* (s. pranayam, a yoga-breathing technique characterised by slow, rhythmical and deep breathing cycles) have not been reported. We got interested in this study because subjects who had received uniform training in yoga and claimed to experience a deeply restful and enjoyable feeling during the practice of s. pranayam were available for the study. They claimed that the technique is not difficult to perform and produces an immediate and deep relaxation of the body and mind. Since *shavasan* also is known to produce psychosomatic relaxation and has been shown to be effective in the treatment of hypertension (Datey et al, 1969; Patel and North, 1975), we planned to study the effects of *s. pranayam* and *shavasan* on O_2 consumption, blood pressure (BP) and heart rate (HR).

2. Materials and Methods

The study was conducted on two groups of healthy volunteers. Group I consisted of 7 trained subjects (27-33 yr; mean: 30.1 yr) who had received uniform training in yoga under one of the authors (S. G.). They had been regularly practising *s. pranayam* and *shavasan* for more than 1 year. Group II consisted of 7 untrained subjects (20-36 yr; mean: 24.8 yr.). They were given instructions about the techniques of *s. pranayam* and *shavasan* and their recordings were taken 2-5 days later. During these few days, they practised *s. pranayam* and *shavasan*. These techniques come from ancient Vedic traditions of India. *S. pranayam* has been described elesewhere (Gitananda, 1978). Essentially, it is a slow, rhythmical and deep breathing, each cycle consisting of four phases: purak (inspiration), kumbhak (held-in), rechak (expiration) and shunyak (held-out) with a ratio of 2:1:2:1. Total duration of a cycle is an individual matter as long as the subject maintains the ratio. Our subjects performed the pranayam with a respiratory rate of 1·4 - 3/min. *Shavasan*, which is yoga relaxation method was done as described by Patel and North (1975), but no biofeedback was used.

All the subjects were highly cooperative and gave their consent readily. During preliminary trials, the subjects were made familiar with the experimental set up and personal rapport was established with them. On the day of the test, the subject reported at the laboratory at 9 a. m , two hours after light breakfast. After resting for 30 min, the study was conducted in supine posture in three successive and continuous periods of 10 min each. The first period consisted of normal resting (control) breathing. The second and third periods consisted of *s. pranayam* and *shavasan* respectively. The trained subjects did meditation during *s. pranayam* as well as *shavasan*. Untrained subjects were not taught the technique of meditation and did not meditate.

A tight-fitting facial mask and a closed circuit basal metabolism apparatus (Dr. Durupt's Apparatus, Ets Jouan, Paris) were used to record O_2 consumption and respiratory rate (RR). In a few subjects, the O_2 consumption was also determined by open circuit method (Hartmann & Braun, Frankfurt) and the results were similar to those found by the closed circuit method. HR was determined by auscultation of precordium and brachial arterial BP by sphygmomanometer. Measurements during the latter half of each study period (during steady state condition) are presented. The laboratory temperature on different days of the study period varied between 31.5 to 32.1°C but did not vary during a particular experiment.

3. Results

The results obtained during the steady-state of *s. pranayam* and *shavasan* are given in Table 1 and Figs. 1-3. Control RR was less in

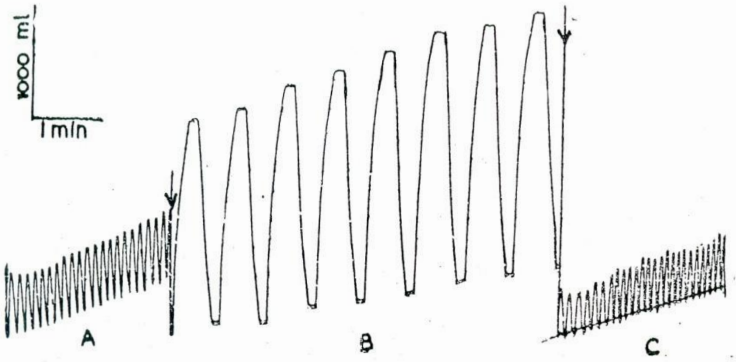

Fig. 1. Spirometric record showing respiratory pattern and O_2 consumption during control (A), savitri pranayam (B) and shavasan (C). Inspiration is represented by upward deflection of the pen. Arrows indicate replenishment of O_2 in the spirometer.

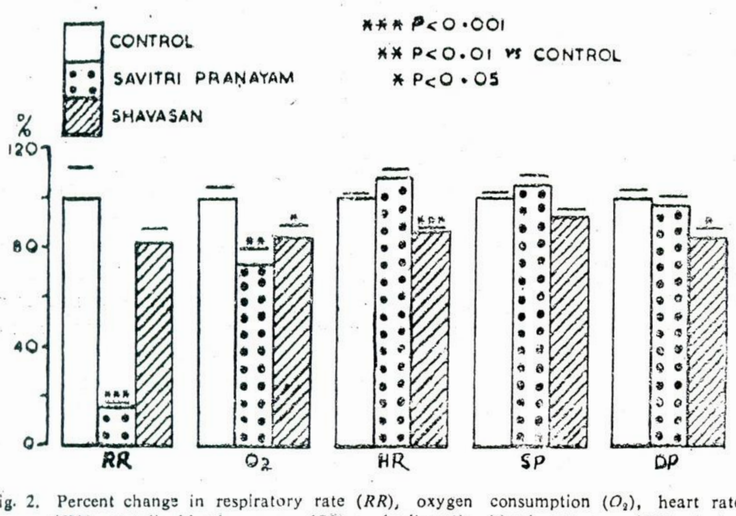

Fig. 2. Percent change in respiratory rate (*RR*), oxygen consumption (O_2), heart rate (*HR*), systolic blood pressure (*SP*) and diastolic blood pressure (*DP*) during savitri pranayam and shavasan in trained subjects. Horizontal lines represent means $\pm$ *SEM*.

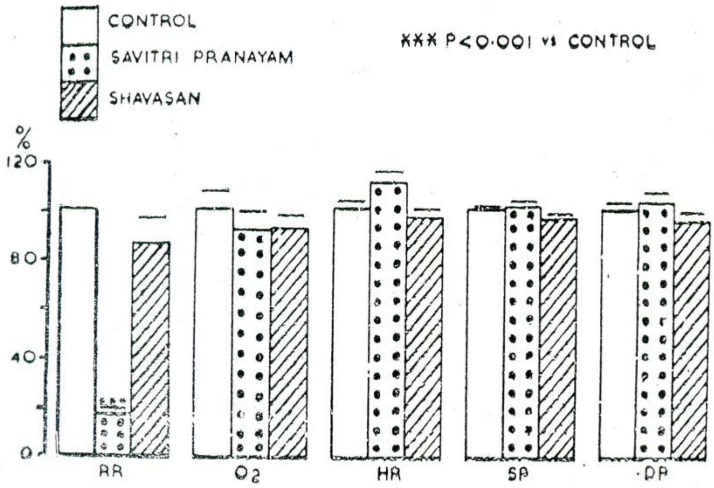

Fig. 3. Percent change in respiratory rate (*RR*), oxygen consumption (O_2), heart rate (*HR*), systolic blood pressure (*SP*) and diastolic blood pressure (*DP*) during savitri pranayam and shavasan in untrained subjects. Horizontal lines represent means ± *SEM*.

trained than in untrained subjects. In both groups, RR was considerably low ($P<0.01$) during *s. pranayam*, but during *shavasan*, there was insignificant decrease in RR. O_2 consumption was significantly reduced during *s. pranayam* ($P<0.01$) and *shavasan* ($P<0.05$) in trained group. But in untrained group the reduction in O_2 consumption during *s. pranayam* and *shavasan* was not significant. During *s. pranayam* there was statistically insignificant increase in HR in both the groups. On the other hand, *shavasan* produced a significant ($P<0.001$) decrease in HR in the trained group. In both the groups, *s. pranayam* produced an insignificant rise and *shavasan* an insignificant fall in systolic BP. Diastolic BP did not change much during *s. pranayam* in either group. *Shavasan* produced a significant ($P<0.05$) reduction in diastolic BP in the trained group.

4. Discussion

It is claimed that pranayam and meditation calm the mind and lead to deep relaxation and pleasant feeling (Vivekanand, 1975; Wallace, 1970 ; Wallace *et. al.*, 1971). In our trained subjects, a remarkable decrease (26%) in O_2 consumption during *s. pranayam* and meditation corraborates with above statement, and with the findings of Wallace *et al* (1970; 1971) who reported 17-20% reduction in O_2 consumption during Transcendental Meditation. Mind and body are intricately interrelated. Yogic techniques have been designed to act simultaneously on both, thereby exerting a great influence on one's psychosomatic functions. During pranayam a definite pattern of afferent input reaches hypothalamus and other brain centres which along with the meditative techniques might modulate the neuronal activity. Here it is interesting to note that meditation (Wallace, 1970) and pranayam (Chhina *et. al.*, 1978) have been shown to increase the amplitude and percentage time of alpha activity in resting EEG. In our subjects *s. pranayam* was immediately followed by *shavasan* during which O_2 consumption continued to be appreciably low (even when some subjects did the pranayam for longer duration). At the end of the study, the subjects reported that they felt fresh and energetic. This suggests that the trained subjects did not incur hypoxia or hypercapnea while practising *s. pranayam* at a rate of 1.7 cycles/min. Chhina (1974) also has reported that yogis can maintain RR of 1-3/min for several hours.

In his studies on a single subject, Miles (1964) has reported that during *uijayi pranayam* (which is done by taking a deep inspiration, followed by a prolonged retention and a deep expiration without keeping a ratio between these three phases) performed at a rate of 1.2 cycles/min, O_2 consumption increased by 19%. On the other hand, our trained subjects achieved a consistent and remarkable decrease in O_2 consumption while practising *s. pranayam* at a rate of 1.7/min. This might be due to difference in techniques of the two pranayams, difference in training or the fact that our subjects were doing meditation along with the pranayam.

Normally, O_2 consumption cannot be reduced voluntarily while a whole night's sleep lowers it by 9-13% (Jana, 1965, Morehouse and Miller, 1963). But 10 min practice of *s. pranayam* produced about 26% reduction in O_2 consumption in our trained subjects. The decrease in O_2 consumption during *shavasan* was significant but less marked (16%) than during *s. pranayam*. During *s. pranayam* as well as *shavasan*, our trained subjects were deeply relaxed as could be judged by passive movements of their limbs and palpation of their muscles.

In comparison to trained subjects, untrained subjects showed only a slight decrease in muscle tone and an insignificant reduction in O_2 consumption during *s. pranayam* and *shavasan*. This difference might be due to the effect of training and the fact that trained subjects did meditation during *s. pranayam* whereas untrained subjects did not meditate.

During *s. pranayam*, there was an increase in HR and systolic BP of both the groups. This can be explained on the basis of increased venous return as a result of deep breathing in supine posture, afferents from vagal stretch receptors and irradiation of impulses to the cardio-vascular centres from the respiratory centre (Detweiler, 1979; Ganong, 1977). However, these changes were not statistically significant in either group. An increase in sympathetic activity is unlikely as diastolic BP remained practically unchanged in both the groups. During *shavasan* there was a slight decrease in HR and BP in the untrained group. But in the trained group, there was significant decrease in HR and diastolic BP. Our findings are different from those of Wallace *et. al.*, (1971) who found little change in HR and BP during the practice of Transcendental Meditation. Datey *et. al*, (1969) and Patel and North (1975) have reported that shavasan has a great therapeutic effect in essential hyper-tension. They attributed this to a decrease in the frequency and intensity of proprioceptive and enteroceptive impulse traffic reaching the hypothalamus. Our finding of a significant decrease in O_2 consumption, HR and diastolic BP during *shavasan* in trained subjects might lead to a better understanding of its therapeutic value. These findings are suggestive of a decrease in the sympathetic activity. However, this needs further study.

5. Conclusion

The present study shows that by the practice of *s. pranayam* and *shavasan* along with meditation, it is possible to achieve psychosomatic relaxation and a reduction in O_2 consumption. Since these techniques are not difficult to perform and are free from deleterious effects of drugs, it is desirable that further studies on their physiological effects be carried out. Moreover, studies on their therapeutic value in stress-induced disorders may be fruitful.

Acknowledgement

The authors gratefully acknowledge the whole-hearted cooperation of Smt. Meenakshi Devi and the subjects who acted as volunteers.

TABLE 1 Effect of *savitri pranayam* and *shavasan* on respiratory rate (RR); oxygen consumption (O_2, ml/min); heart rate (HR); systolic blood pressure (SP, mm Hg) and diastolic blood pressure (DP, mm Hg)

	RR	O_2	HR	SP	DP
			Group I (Trained subjects)		
Control	10.2 ± 1.3	280.7 ± 14.2	73.1 ± 1.5	115.4 ± 3.0	78.2 ± 3.0
Savitri pranayam	1.7*** ± 0.1	206.8** ± 19.2	79.0 ± 2.6	121.3 ± 4.8	76.1 ± 3.2
Shavasan	8.4 ± 0.6	236.4* ± 15.7	63.0*** ± 1.4	107.1 ± 3.2	66.0* ± 3.4
			Group II (Untrained subjects)		
Control	15.7 ± 0.9	298.8 ± 20.8	73.0 ± 2.4	107.5 ± 1.3	69.0 ± 1.8
Savitri pranayam	2.7*** ± 0.3	273.5 ± 22.2	80.7 ± 2.9	109.5 ± 2.5	71.5 ± 2.6
Shavasan	13.5 ± 1.6	274.5 ± 16.2	70.4 ± 2.7	103.4 ± 2.0	65.8 ± 2.6

Values given are means ± SE.

Significantly different from the control values (by the student's '*t*' test): *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

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