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Physiological Effects of Yogic Practice

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W Selvamurthy ,

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, H S Nayar, N T Joseph &, S Joseph,

- Defence Institute of Physiology & Allied Sciences Delhi Cantt - 110010, India.

Abstract

A comprehensive study was conducted on 30 healthy men (20-30 years of age) to evaluate the effects of six months of regular yogic practice on autonomic balances, thermoregulatory efficiency, orthostatic tolerance, energy metabolism and biochemical profile. The subjects were randomly divided into two groups (A & B) of 15 each, Group-A served as control, while in group-B yogic training was administered daily in the morning hours for one hour under the supervision of qualified Yoga Instructor from Vishwaytan Yogashram for six months. Various physiological tests and biochemical estimations were done before, and after every month of yogic training, in both the groups. Yogic practice for six months resulted in a trend of shift in the autonomic equilibrium towards relative parasympathodominance, improvement in thermoregulatory efficiency and orthostatic tolerance. It has also brought about improvement in physical performance by minimising the energy expenditure during submaximal exercise. The changes in the biochemical profile indicated a relative hypometabolic state after six months of yogic practice. Physiological significance of these findings is discussed in this paper.

Introduction

Yoga is an ancient Indian science which is claimed to help develop perfect physical, mental and spiritual health. Several scientific studies have been conducted previously on Yogis who have been practising yoga for several years. It has been observed that yogis can reduce their oxygen utilization [1] and also control their pulse through the respiratory manoeuvres [2]. Yogis are reported to possess a reduced level of sympathetic tone [3] and exert certain degree of voluntary control over autonomic functions. The practice of specific yogic exercises has proved to be useful in the management of hypertension [4]. Jacques Mayol [5] who held the world record in breath hold diving attributed his success to the yogic practice. Recent report by Benson et al [6] showed that thermoregulatory efficiency can be voluntarily modulated by the practice of g Tum-mo Yoga. The physiological basis and rationale underlying these observations are not yet clearly understood. Moreover, only limited studies are available on the physiological effects of short-term yogic practice [7], [8], [9]. The studies conducted on NDA cadets [9] revealed that the yogic practice, if initiated in young age can improve the cardiorespiratory functions within one year of training. The present comprehensive study has been undertaken to evaluate the effects of six months of yogic practice on physiological and biochemical profile in young healthy men.

Material and Methods

The study was conducted on 30 healthy physically active men (soldiers) in the age group of 20-30 years, who were divided into two groups (A & B) of 15 each. Group-A subjects served as control and they performed the physical training (PT) exercises of Army routine, daily for one hour. These exercises consisted of body flexibility exercises, slow running for a distance of about 2 km, pull-ups and games. In group-B, yogic training was administered daily for one hour in the morning hours, under the supervision of two qualified yoga instructors from Viskhwaytan Yogashram, New Delhi, for a period of six months.

The mean ± s.e.m values of age, body-weight and height of the control subjects were 23.6 ± 0.7 years, 62.9 ± 1.3 kg, and 171.3 ± 1.5 cm respectively; whereas, in yoga group these were 25.4 ± 0.9 years, 61.6 ± 1.8 kg, and 172.6 ± 1.2 cm respectively. All the subjects were maintained on a diet supplying 3700 KCal and controlled physical activity schedule throughout the period of the study. The physiological and biochemical parameters were monitored in thermoneutral conditions (27 ± 2° CDB and 45-55% RH) before the commencement of the yogic training and periodically during the extent of the study, in both the groups. The yogic schedule consisted of prayer (3 minutes), asanas (50 min), pranayama (5 min) and meditation (5 min). Asanas practised by the group-B subjects are listed in Table I. All these asanas were practised by every subject in group-B. Pranayama schedule included the deep breathing, inhalation-retention-exhalation at fixed intervals, abdominal (diaphragmatic) breathing and alternate nostril breathing [10]. All the breathing exercises and meditation were performed in Padmasana posture. During meditation the subjects were asked to close the eyes and concentrate the attention on their own breathing rhythm or in saying the mantra "OM" in soft voice. Yoga group (B) subjects were, strictly, not permitted to perform any other PT exercise during the period of the study.

Table I - List of yogic exercises

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The status of autonomic equilibrium was assessed by a battery of parameters such as heart rate (HR), blood pressure (BP), oral temperature (Tor), mean skin temperature (Tsk), cold pressor response (CPR) at 4° C water, and cardiovascular responses to 70° head-up tilt on a tilit table [11]. In addition alpha index of EEG (occipital) was also measured [12]. Energy metabolism was monitored during resting condition, submaximal and maximal exercise on a bicycle Ergometer by recording the oxygen consumption, blood lactic acid, pulmonary ventilation and heart rate. Thermoregulatory efficiency was assessed by monitoring the rewarming patterns after cold immersion of hand at 10° C water for 2 minutes [13].

The following biochemical indices were also estimated: Blood glucose by the methods of Nelson [14], plasma cholesterol by Anderson and Keys [15], total proteins by Lowry et al [16] and the free fatty acids by the method of Anstall [17]. Plasma cholinesterase and lactic dehydrogenase activity was quantified by the method of De La Huerga [18] and Wroblewski and La Due [19] respectively. Lipoproteins were estimated by gel electrophoresis [20]. Dopamine β -hydroxylase activity was assessed by the method of Nagastu and Udenfriend [21] and Monoamine oxidase by the method of Ono et al [22]. Urinary 17-keto and 17-hydroxy steroids were estimated by the technique of Ludwig [3] and Drekter et al [24] respectively. These tests were performed before the initiation of the yogic practice and periodically during different periods of yogic training.

Table II - Effects of yoga on some physiological variables in control (C) and yoga (Y) group of subjects

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The Values are man ± SE

The statistical analysis of the data was done by the method of Analysis of Variance.

Results

The changes in cardiovascular functions during six months of yogic practice have been shown in Fig. 1. HR and BP showed gradual decline during yogic practice in group-B and were lower than their own initial values ($P < 0.001$) and their control counterparts ($P < 0.01$). The Tor did not show any appreciable change except at the end of first month of yogic training when it showed a significant decrease in both control and yoga group of subjects due to the drop in ambient temperature during winter season; however, yoga group maintained relatively higher ($P<0.05$) skin temperature. The cardioacceleration during tilt was of lesser magnitude in yoga group (Fig.2). The alpha index of EEG showed a significant increase ($P<0.001$) after six months of yogic practice (Fig. 3). The average amplitude also showed similar response. Rewarming curves in both control and yoga groups showed leftward shift during 4th, 5th and 6th months of experimental period; but the shift was more in yoga group (Fig. 4 a & b). The percentage of subjects showing orthostatic intolerance, as manifested by a drop in systolic BP during 15 minute tilt, was less in yoga group after yoga training (Table III).

Cardiovascular responses to six months of yogic practice. Values are mean ± s.e.m

Reduction in the magnitude of cardioacceleration during tilt in yoga group as shown

Alpha index of EEG showing a significant elevation in yoga group

Rewarming curves in Control (A) and Yoga (B) groups during different periods of yogic training

Table IIIa - Percentage of subjects showing normal (N) and orthostatic intolerance (OI) response in the control and yoga group of subjects during different months of yogic training

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Table IIIb1 - Percentage of subjects showing normal (N) and orthostatic intolerance (OI) response in the control and yoga group of subjects during different months of yogic training

Table IIIb1 - Percentage of subjects showing normal (N) and orthostatic intolerance (OI) response in the control and yoga group of subjects during different

months of yogic training

The physiological responses to the standard submaximal exercise are shown in Table IV. The exercise heart rate and oxygen consumption were reduced significantly ($P < 0.001$) after six months of yogic practice. There was no change in the build-up of lactic acid in the arterial blood. Net mechanical efficiency increased significantly ($P < 0.01$) after yogic training. Responses to maximal exercise were almost unaffected after yogic training.

Table IV - Physiological responses to submaximal exercise

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Values are mean ± SEM

The blood glucose, cholesterol and Dopamine β -hydroxylase were decreased, while Monoamine oxidase, lactic dehydrogenase, plasma cholinesterase and urinary excretion of 17-hydroxy and 17-keto steroids showed significant increase ($P < 0.01$) after six months of regular yogic practice (Table V).

Table V - Physiological responses to submaximal exercise

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Values are mean ± SEM

Discussion

The regular yogic practice for six months has been observed to improve various physiological functions of the body. Significant decrease in HR, diastolic BP, Tor, and cardioacceleration to tilt, and increase in Tsk and alpha index of EEG indicate a trend of gradual shift of autonomic equilibrium towards relative parasympathodominance due to reduction in the sympathetic activity. Biochemical and neurohumoral changes such as reduction in blood DBH and blood glucose, and increase in MAO, plasmocholinesterase and urinary 17-keto and 17-hydroxy steroids confirm this shift [25]. This modulation of ANS activity, probably might have been brought about through the conditioning effects of yoga on autonomic functions [26] and mediated through the limbic system [1] and higher areas of central nervous system.

The individuals practising yoga develop some degree of resistance against physical stress, which is evidenced from the relative stability of mental fatiguability index during stress [27]. This may be useful for the personnel who are likely to be exposed to various kinds of stressful environments and terrain, as in the case of Armed Forces, where stable autonomic equilibrium has been reported to be useful to face the stress more effectively [11], [28], [29].

The greater magnitude of leftward shift of the rewarming curves in yoga group of subjects indicate improvement in thermoregulatory efficiency due to yogic training. The magnitude of cold induced vasoconstriction is less in yoga group as a result of quiscence of sympathetic activity. The improvement in themoregulatory efficiency as a consequence of yogic practice has been observed by other workers also [6], [30]. This effect is probably due to the improved function of hypothalamic themoregulatory mechanism and autonomic mediation.

Cardiovascular response to orthostasis has also shown significant improvement after yoga. The cardioacceleration to tilt is less in the yoga group. On the other hand, these subjects maintained their systolic BP during orthostasis more effectively than their control counterparts (Table III). This suggests that yoga helps to improve the cardiovascular efficacy and the homeostatic control machinery of the body.

Significant reduction in the exercise heart rate and oxygen consumption with a concommitant increase in the net mechanical efficiency during submaximal exercise indicate improvement in physical performance after yoga training. These effects could be secondary to the shift in autonomic balance. Studies of Nayar et al [19]. also showed that there was improvement in cardiorespiratory functions in NDA cadets after one year of yoga training. Salgar et al [13] reported increase in muscular efficiency due to yogic exercise.

Meditation which is essentially a part of yogic schedule is also reported to produce hypometabolic state, increase in alpha activity of EEG and skin resistance reflecting a low level of anxiety [32]. The practice of Hatha-Yoga, Pranayanma and different bandhas have specific influence over autonomic functions, activity of CNS and endocrine system; however, some of the asanas have nonspecific effects [3], [4], [5]. The yogic schedule in the present study has been designed to influence various systems of the body. The stable autonomic equilibrium and relative hypometabolic state achieved by the yogic practice may be the scientific basis for the claim that yogic practice endows perfect physical and mental health.

From these finding, it is concluded that the yogic practice helps to achieve a stable autonomic balance and also to develop a relative hypometabolic state. There is also improvement in physical efficiency, thermo-regulation and orthostatic tolerance as a consequence of regular yogic practice for six months.

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