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RESEARCH ARTICLE

REDUCTION OF CARDIOVASCULAR HYPER REACTIVITY AFTER 12 WEEK PRACTICE OF UJJAYI PRANAYAM AND SHAVASAN IN ADULT HUMAN VOLUNTEERS

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ABSTRACT

Background: Stress and anxiety have been implicated as contributors to many chronic diseases and to decreased quality of life, even with pharmacologic treatment. Efforts are underway to find non-pharmacologic therapies to relieve stress and anxiety, and yoga is one option for which results are promising. (Li and Goldsmith, 2011)

Aims & Objective: The aim of present study was to investigate whether regular practice of Yoga for 12 weeks can reduce the cardiovascular hyper-reactivity induced by cold pressure test.

Materials and Methods: The study group comprises 50 healthy subjects of 18 - 25 years age group. At the beginning of the study, there were 22 hyper-reactors to cold pressure test. The hyper-reactivity of 16 (72.72%) volunteers converted to hypo-reactivity after the yoga therapy of 12 weeks. Other parameters like basal blood pressure, rise in blood pressure after cold pressure test, pulse rate and Rate Pressure Product (RPP) were also statistically reduced up to significant level.

Result: Regular practice of yoga significantly reduces values of basal blood pressure, cardiovascular hyper-reactivity to blood pressure after one minute of cold stress, heart rate, & rate pressure product after 12 weeks of yoga practice.

Conclusions: Non-pharmacological methods like yoga, meditation, diet, weight reduction and life style modification should been encouraged to control the modifiable risk factors. The cardiovascular parameters alter with age, but these alterations are slower in persons ageing with regular yoga practice. It can thus be concluded that these results and their explanations would justify the incorporation of yoga as part of our life style in prevention of age–related cardiovascular complications.

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INTRODUCTION

Psychosocial stresses of our modern life precipitates various cardiovascular and other disorders by distorting basic neuroendocrine mechanism. The psychosocial stresses activate limbic system and hypothalamus which stimulate autonomic nervous system, increase in output of both adrenaline and nor-adrenaline, both from sympathetic nerve fibers as well as from adrenal medulla causing increase in heart rate, systolic and diastolic blood pressures and an increased secretion of glucocorticoid and aldosterone from adrenal cortex causing salt and fluid retention which increases blood volume and blood pressure imposing severe strain on the heart. (Indla Devasena Pandurang Narhare, 2011) Walter Cannon (1911) *et al* was the first person to propose that emotional stress causes excess of adrenaline secretion from adrenal medulla leading to tachycardia, high blood pressure etc. Later it was found that all these manifestations occur not only from adrenaline secretion but also from over activity of the sympathetic nervous system which liberates nor-adrenaline at its nerve endings. (Walter Cannon, 1911) Cardiovascular disease has become a major cause of mortality in developing nations in the age group of 30-69 years; the cardiovascular mortality due to hypertension is seen more in developing nations. (Reddy, 2004; Gaziano, 2007) Hines & Brown in 1932 devised a method to test the reactivity of the body to cold stress. They observed the effect of pain caused cold stress in the form of rise in blood pressure and on this basis subjects could be classified as hypo-reactors or hyper-reactors. The hyper-reactors to cold stress are likely to develop cardiac disorders later on in any phase of life. These hyper-reactive subjects should be properly dealt with to lower

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the incidence of such disorders. (Hines and Brown, 1932; Hines and Brown, 1936) Yoga is a spiritual science for the integrated and holistic development of our physical, mental and moral-spiritual aspects of being. The philosophy of Yoga is practical and applicable in our day-to-day living. Yoga has been documented to normalize physiological function and recent advances in the field of research have shown that it has sound scientific basis. Pranayama is a part of the ancient Indian art of yoga, which is the fourth step of ashtanga yoga. Pranayama is a controlled and conscious breathing exercise which involves mental concentration. Man is subjected to stress during the day to day activities and stress related problems like essential hypertension, angina, psychoneurosis, gastric ulcer, asthma and insomnia very commonly occur. The cardiac functions are controlled primarily by the vagal and the sympathetic tones. Abnormalities of the sympathovagal balance, added to the stress, lead to major cardiovascular dysfunctions like ischemic heart diseases and hypertension. (Lathadevi *et al*., 2012) In the ancient Indian vedic literature, it has been indicated that breathing with consciousness improves the mental and physical health. There are different types of pranayamas that are specially advised for the treatment of various disorders. There are evidences that pranayama training produces a deep psychosomatic relaxation (Madanmohan *et al*., 1983; Rai *et al*., 1982) and an increase in the cardio-respiratory efficiency (Gopal *et al*., 1973), and the autonomic functions (Pal *et al*., 2004). Yoga, developed thousands of years ago, is recognized as a form of mind–body medicine . In yoga, physical postures and breathing exercises improve muscle strength, flexibility, blood circulation and oxygen uptake as well as hormone functions. In addition, the relaxation induced by shavasana and meditation helps to stabilize the autonomic nervous system with a tendency towards1 parasympathetic dominance. Yoga is effective for prevention as well as management of bronchial asthma, stress due to exams, anxiety and depression, stress in hypertensive patients, and in cure/control of essential hypertension (Parshad, 2004). Yoga is also known to improve subjective well being. The physiological benefits which follow, help yoga practitioners to become more resilient to stressful conditions. One such yogic exercise which enhance s one's ability to combat stressful situation is Shavasana. Shavasana can enhance the parasympathetic activity, blunt the sympathetic activity and reduce the load on heart. (Ray *et al*., 2001)

MATERIALS AND METHODS

The aim of present study was to investigate whether regular practice of Yoga for 12 weeks can reduce the cardiovascular hyper-reactivity induced by cold pressor test. Study group comprised 50 male healthy subjects of 18 -25 years. They were subjected to cold pressor test according to Hines & Brown.[18] Out of 50 volunteers, 22 turned out to be hyper-reactive to this provocative test. The hyper-reactivity of 16 volunteers converted to hypo-reactivity after the yoga therapy of 12 weeks (72.72 %). Other parameters like basal blood pressure, rise in blood pressure, pulse rate and Rate Pressure Product (RPP) were also significantly reduced statistically as is evident by "student 't' test". The study protocol was explained to the subjects and written consent obtained. Approval by ethical committee of S.S. Medical College, Rewa, M.P., was obtained. All the volunteers were clinically examined to rule out any systemic diseases. All subjects were non-alcoholic and non-smokers. They were not taking any drugs, and they had similar dietary habits as well as physical and mental activities at work and home. These hyper-reactive volunteers performed yoga twice a day, in the Department of physiology, S. S. Medical College, Rewa. M. P.

Heart rate (beats per minute)

The subjects were asked to rest in supine position for 15minutes. After fixing the leads the subject was asked to lay quietly for 3 minutes. At the end of 3 minutes resting heart rate was recorded using ECG.

ECG was recorded in lead 2, which was run for one full minute for each test. The R-R peaks indicated the heart rate and the calculation was done noting the speed of the ECG paper in unit time. Since 25 mm/second is the speed normally used, the heart rate is counted with the following calculation:

$$\text{Heart rate/minute} = \frac{1500}{\text{Distance between two consecutive R-R waves in mm}}$$

Systolic and diastolic blood pressure (mmHg) by using sphygmomanometer

The subject was asked to rest in supine position for 15minutes. The blood pressure was recorded by means of sphygmomanometer by auscultatory method. Three BP recordings at one minute interval were taken and the lowest of these values was included for the study. The subjects were asked to relax during the procedure. (Perloff *et al*., 1993)

The rate pressure product

(RPP = HR x SP)/100, were calculated for each reading. All the above parameters were measured before and after six weeks of the ujjayi pranayama and shavasana training in the Group I subjects. All the parameters were recorded initially and after six weeks in the Group II control subjects also. Rate Pressure Product is an easily measurable index, which correlates well with myocardial oxygen consumption and defines the response of the coronary circulation to myocardial metabolic demands.

Cold pressor test

For cold pressor test, a thick walled thermocol box measuring 38 cm × 26 cm × 18 cm, closed from all sides, was used. A hole was made in the centre of the top of the box to allow entry to one hand of the subject. Another small hole was made at the corner of the top of the box for laboratory thermometer. Before starting the experiment the box was filled a mixture of ice and water and the laboratory thermometer was placed such that its mercury bulb was immersed in the mixture of ice and water. (Hines and Brown, 1932) Temperature inside the box was measured about 3^0-4^0C. The hand was immersed in cold water up to the wrist for one minute (cold stress). An elevation above the basal level of more than 20 mm of Hg in systolic or of more

than 15 mm in diastolic was considered as hyper-reactive response. [7] All the volunteers were trained under the guidance of a certified "yoga" teacher for 15 days. They carried out "Ujjayee Pranayama Meditationan and Shavasana, for 60 minutes, twice a day for 12 weeks, under supervision, in a prescribed manner. The schedule consisted of-

"Ujjayee Pranayama- -10 minutes
Meditation- -30 minutes
Shavasana- -20 minutes

Ujjayi Pranayama – The subjects were asked to sit in a comfortable posture, keeping the back erect and rigid, with their eyes closed. They were instructed to do slow deep inspiration, followed by slow deep expiration, with breathholding in between, by observing the mula bandha. This cycle was repeated for 5 to 10 minutes. (Lathadevi *et al*., 2012)

The shavasana – Subjects lay supine, with all the muscles being totally relaxed for 20 minutes. The Subjects were asked to concentrate on the process of inspiration and expiration. During the training period, the practice sessions were held for 20 minutes daily in the early morning on an empty stomach, under the supervision of an experienced yoga teacher. The subjects were instructed to do the same before dinner for a period of 12 weeks.

The volunteers practiced these exercises early in the morning and again in evening, in a quiet, well ventilated room or in open air space in a comfortable posture. (Lathadevi *et al*., 2012)

Statistics

The data was analyzed statistically by using statistical software Graph Pad in Stat vs. 3.10 and MS Excell (2003). Statistical analysis of BP, pulse rate and respiratory rate were done using student't' test and $p < 0.05$ was considered as significant.

RESULTS

Our results showed that "Yoga" causes significant reduction in the cardiovascular hyper-reactivity. A total of 50 male volunteers were included in the study. Out of which 22 were hyper-reactor to cold pressor test. These hyper-reactors practiced yoga regularly for 12 weeks and after this period 16 volunteers became hypo-reactors. However, the hyper-reactivity did not change in 06 volunteers. The statistical analysis was carried out using student t test. It was observed that the basal blood pressure, rise in BP due to cold stress (Table-1) and, heart rate and Rate Pressure Product were statistically more significantly altered. (Table-2)

Blood Pressure: The basal mean systolic blood pressure decreased from123.9±5.362 mm Hg to 122.81 ± 3.936 mm Hg after 12 weeks of yogic exercises, pranayama and meditation.(P value 0.083). The diastolic Blood pressure was found in the study to change from 82.0 ±3.381 mm Hg to 77.36 ±3.512 mm Hg. (P Value 0.000) Average rise in systolic blood pressure, due to cold pressor test, initially was 21.64 ± 4.645 mm Hg, and this rise reduced to 15.45 ± 3.609 mm Hg ($p<0.000$). While the rise in diastolic blood pressure initially was 15.45 ± 3.609 mm Hg and this reduced to 13.36 ± 1.891 mm Hg ($p<0.000$).

Heart rate and Rate Pressure Product (RPP)

Heart rate decreased from mean value of 75.59 ± 3.813 per minute to 71.55 ± 3.474 beats per minute ($p <0.000$) and RPP decreased from mean value of 93.47 ± 6.481 to 87.83 ± 5.105 which is significant. (p value < 0.000)

DISCUSSION

On analyzing the effect of yoga in normal subjects of age group 18-25 years, in our study, the cardiovascular autonomic function tests were studied out before and after 12 weeks of "yoga". The volunteers after "yoga" practice showed autonomic equilibrium between sympathetic and parasympathetic nervous system. In the present study we observed that there was significant reduction in blood pressure, Heart rate, Rate Pressure Product (RPP) and reactivity to cold pressor test after practicing "yoga" which indicates decrease in sympathetic activity and increase in parasympathetic activities which is mainly due to increase in vagal tone. (Gharote, 1973; Gopal *et al*., 1973; Vyas *et al*., 2002; Udupa *et al*., 2003) The purpose of this study was to determine whether the pranayama and shavasana training modulated the cardiovascular responses. The ujjayi pranayama and the shavasana training for 12 weeks resulted in a significant decrease in the basal heart rate, the blood pressure and the response to cold stimulus in the hyper reactive subjects. The basal heart rate is the function of the para-sympathetic system. The calculated RPP also decreased significantly, as RPP was an index of the myocardial oxygen consumption and the load on the heart (Gobel *et al*., 1978). A significant Decrease in the RPP following the pranayama training in the hyper reactive subjects, indicated a reduction in the work which was done by the heart. Madanmohan and Rai *et al* also reported that the pranayama training resulted in a decrease in the oxygen consumption (Madanmohan *et al*., 1983; Rai *et al*., 1982) these studies showed that the pranayama training produced an overall reduction in the oxygen consumption, the metabolic rate and the load on the heart. Hence, our study showed that a pranayama training of 12 weeks duration produced a decrease in the basal sympathetic tone and an increase in the basal parasympathetic activity. The Sanskrit word 'ujjayi pranayama' means victorious breath. The prefix, "ud" means upwards or expanding and "jayi" means conquest or success. Pramanik *et al*., reported that slow breathing exercises influenced the heart rate and the blood pressure through the para-sympathetic dominance (Pramanik *et al*., 2009; Pramanik *et al*., 2010) As ujjayi pranayama, followed by shavasana, is a type of slow breathing exercise, it stimulates the para-sympathetic system. Pranayama makes the person concentrate on the process of breathing, and it de-stresses him. This may decrease the release of adrenaline i.e., decrease the sympathetic activity and hence, it may decrease the heart rate and the blood pressure (Gobel *et al*., 1978). In the present study, ujjayi pranayama showed a significant decrease in the heart rate and the blood pressure, which was supported by the findings of a study which was conducted by Pramanik *et al*. (Gobel *et al*., 1978).

Table 1. Changes in Blood Pressure in mm Hg. during Cold Pressor Test In Hyper reactors before and after 12 weeks of Ujjayee Pranayam and Shavasan

S.No.	Parameters		Before Ujjayee Pranayam & Shavasan		After 12 Weeks of Ujjayee Pranayam & Shavasan		P Value
	Blood Pressure (mm Hg		Mean Value	S.D.	Mean Value	S.D.	
1	Basal B.P.	Systolic	123.9	±5.362	122.81	±3.936	P<0.000
		Diastolic	82.0	±3.381	77.36	±3.512	P<0.000
2	B.P. after Hand dip in 4^0 water for 1 minute	Systolic	145.5	±9.091	140.27	±6.393	P<0.000
		Diastolic	97.45	±6.33	90.93	±4.881	P<0.000

Table 2. Comparison of Heart Rate and Rate Pressure Product (RPP) in Hyper reactive Subjects before and after 12 weeks of Ujjayee Pranayam and Shavasan

S. No.	Parameters	Before Ujjayee Pranayam and Shavasan		After 12 Weeks of Ujjayee Pranayam and Shavasan		P Value
		Mean Value	S.D.	Mean Value	S.D.	
1	Heart Rate/ min.	75.59	±3.813	71.55	±3.474	P<0.000
2	Rate Pressure Product (RPP)	93.47	±6.481	87.83	±5.105	P<0.000

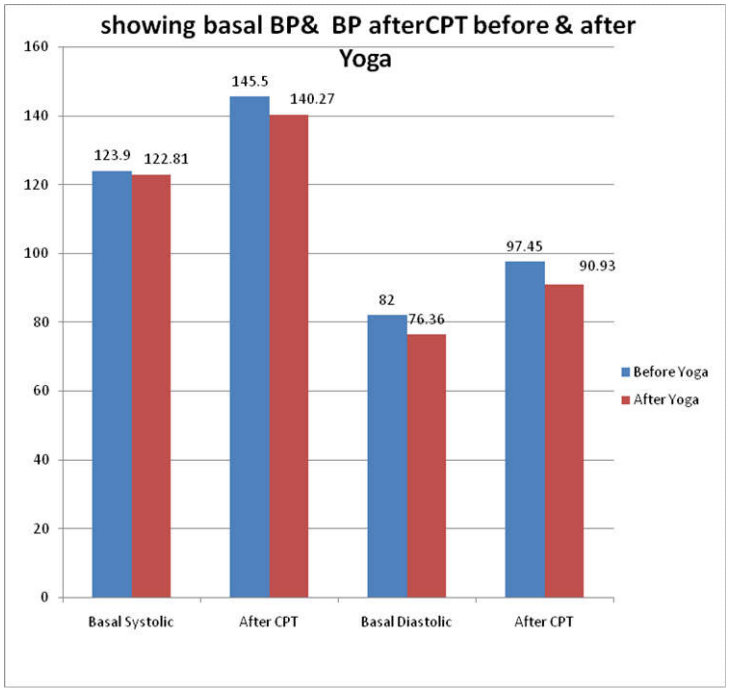

Fig.1.

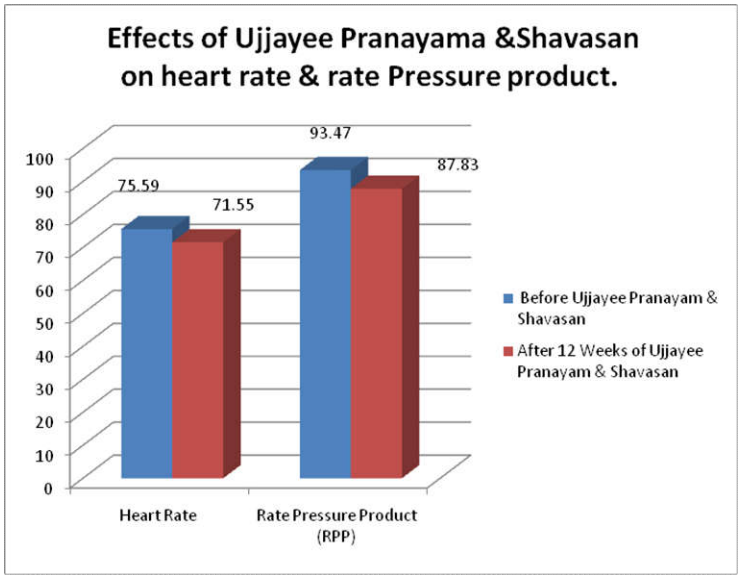

Fig.2.

Pranayama increases the frequency and the duration of the inhibitory neural impulses by activating the stretch receptors of the lungs during the tidal volume inhalation as in the Hering-Breuer reflex. This brings about a withdrawal of the sympathetic tone in the skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing a decrease in the peripheral resistance and thus decreasing the diastolic pressure in our study. In shavasana, the person relaxes with slow rhythmic movements of the respiratory muscles and other parts of the body. This influences the hypothalamus through a continuous feedback of the slow rhythmic proprioceptive and exteroceptive impulses to reset it at a lower level, thus reducing the blood pressure (Datey *et al*., 1969). During voluntary expiration, the intra-thoracic pressure increases and blood from the lungs is squeezed into the heart, leading to an increase in the stroke volume; the baro-receptors in the carotid sinus experience more pressure and they discharge more. The increased baro-receptor discharge inhibits the tonic discharge of the vasoconstrictor nerves and it excites the vagus innervations of the heart, thus producing vasodilatation, a drop in blood pressure and bradycardia (Ganong, 2005). Most of the volunteers felt a calmness of mind and a sense of well-being, thus supporting the parasympathetic stimulation. Ujjayi pranayama and shavasana thus showed a strong tendency of improving or balancing the autonomic nervous system through an enhanced activation of the para-sympathetic system and thus, they can be practiced for mental relaxation and for the reduction of stress in daily life. Therefore, this simple exercise can be prescribed to hypertensive patients with proper monitoring, along with medical therapy.

Conclusion

The autonomic nervous system plays a major role in bringing about adaptation of human body to environmental changes, thereby modulating the sensory, visceral, motor and neuro-endocrine functions, regulates the activity of all muscles, and certain glands. Autonomic nervous system is one of the most important mediators f this response and these changes may be responsible for the present observation in cold pressor test. (8)

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