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RESEARCH ARTICLE

Effect of Ujjayi Pranayama on cardiovascular autonomic function tests

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ABSTRACT

Background: Life, nowadays, is full of stress, and stress become almost an integral part of our daily routine life. It affects the every aspect of our life and leads to development of stress-related disorders such as hypertension, diabetes mellitus, and many more diseases. **Aims and Objective:** The aim of this study was to investigate whether regular practice of Ujjayi Pranayama for 3 months can reduce the cardiovascular hyperreactivity (stress) induced by cold pressor test. **Materials and Methods:** A total of 60 young healthy individual (35-male, 25-female) were selected who performed Ujjayi Pranayama for duration of 3 months. The cardiovascular hyperreactivity is recorded before and after the regular practice of Ujjayi Pranayama. **Results:** Regular practice of Ujjayi Pranayama for 3 months significantly reduces the cardiovascular hyperreactivity in basal blood pressure (BP), rise in BP after 1 min of cold stress, pulse rate, and rate of respiration. Initially, there were 25 hyperreactors to cold pressor test which reduce to 11 after practicing Pranayama for 3 months. The remaining subjects also reduce their reactivity to cold stress. **Conclusion:** Ujjayi Pranayama can significantly decreases the stress induced changes in cardiovascular parameters because this leads to cardiovascular autonomic balance toward parasympathetic side and cortico-hypothalamo-medullary inhibition.

KEY WORDS: Ujjayi Pranayama; Cold Pressor Test; Hyperreactors; Blood Pressure; Heart Rate; Respiratory Rate

INTRODUCTION

Present day life is full of stress, stress, an inevitable and constant feature throughout the lifetime, induces autonomic dysfunctions which affect physical, mental, behavioral, and emotional health.

Psychosocial stresses of our modern life precipitate 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 noradrenaline, both from sympathetic nerve fibers as well as from adrenal medulla causing increase in heart rate, systolic and diastolic blood pressures (BP) and an increased secretion of glucocorticoid and aldosterone from adrenal cortex causing salt and fluid retention which increases blood volume and BP imposing severe strain on the heart.[1]

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Cardiovascular disease (CVD) remains the biggest cause of death worldwide. As the global population becomes increasingly sedentary, CVD and related diseases such as diabetes and obesity will increase.

In the Indian subcontinent, hypertension has a prevalence of 20-40% among the urban population and 12-17% among the rural population. Studies have shown that about 118 million people in India are with HT, this figure is anticipated to double by 2025.[2-4]

Pranayama (breathing exercise) can produce different physiological responses in healthy individuals. Pranayama

has been reported to be beneficial in treating a range of stress-related disorders, improving autonomic functions, relieving symptoms of asthma, stuttering and reducing signs of oxidative stress.

Breath is the dynamic bridge between body and mind,[5] and Pranayama (breathing techniques) is one of the most important yogic practices, which can produce different physiological responses in healthy individuals.[6] Pranayama is an art of prolongation and control of breath, which helps to bring the conscious awareness in breathing; to reshape breathing habits and patterns.[5]

Slow breathing increases cardiac-vagal baroreflex sensitivity, improves oxygen saturation, lowers BP, intensified vagal activity and reduces anxiety. Within the yoga tradition slow breathing is often paired with a contraction of the glottis muscles. This resistance breath "Ujjayi" is performed at various rates and ratios of inspiration/expiration.[7]

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 evidence that Pranayama training produces a deep psychosomatic relaxation[8,9] and an increase in the cardiorespiratory efficiency[10] and the autonomic functions.[11]

The aim of this study was to investigate whether regular practice of Ujjayi Pranayama for 3 months can reduce the cardiovascular hyperreactivity induced by cold pressor test. The effect of the nonconventional yogic intervention, Ujjayi Pranayama in modulating the cardiovascular functions, was assessed in 60 healthy adults.

MATERIALS AND METHODS

This study "effect of 'Ujjayi Pranayama' on cardiovascular autonomic function tests" was carried out in the Department of Physiology, Shyam Shah Medical College, Rewa, Madhya Pradesh, India.

60 young healthy volunteers aged 17-27 years who were hyperreactors to cold pressor test participated in the study. They were included in the study to perform "Ujjayi Pranayama" for the duration of the 3 months and each subject served as its own control.

The study protocol was explained to the subjects and written consent obtained. Approval by Ethical Committee was obtained.

Each subject under went through a detailed history and clinically examined to rule out any systemic diseases. All subjects were nonalcoholic and nonsmokers. They were not taking any drugs and they had similar dietary habits as well as physical and mental activities at work and home.

All the 60 volunteers trained under the guidance of a certified "yoga" teacher for 15 days. They carried out "Ujjayi Pranayama" 10 min in the morning and 10 min in the evening daily for 3 months, under supervision, in a prescribed manner in a quiet, well-ventilated room or in open air space sitting in a comfortable posture.

BP

BP was measured in supine posture by sphygmomanometer.[12]

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 center 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.[13]

Technique of Test

1. The subject ware allowed to take rest in supine position in a quiet room maintaining the temperature 25-30°C for 20-30 min after that several reading of BP were taken until a basal level was attained approximately.
2. With the subject still in supine position and with cuff of sphygmomanometer on right arm and the opposite hand (left) was immersed in ice water (3-5°C) to a point, just above the wrist joint with the hand still in water reading of BP were taken at the end of 30 and 60 s. The highest of these two reading was noted as an index of the response.[14]
3. The hand was removed from ice water after 60 s, reading had been taken and then the reading was taken every 2 min until the BP returned to its previous basal level.
4. On the basis of the observation as changes in BP the subject was divided into two groups depending on their response to cold stress.[15]
   A. Hyperreactor: Those subjects in whom the systolic BP rise more than 20 mmHg and or diastolic BP more than 15 mmHg or cross the ceiling value of systolic BP more than 145 mmHg and diastolic more than 95 mmHg.
   B. Hyporeactors or normoreactors: Those subjects in whom the systolic BP rise did not exceed 20 mmHg and diastolic 15 mmHg.

Method for Practicing 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 breath holding in between, by observing the mula bandha. This cycle was repeated for 10 min.

Measurement of BP

A mercurial sphygmomanometer was used to record the BP: The cuff was carefully applied on one inch above the cubital fossa and the right brachial artery was located out, the subject was allowed to take rest in supine position for 20-30 min in a quiet room.

After taking the rough systolic BP by palpatory method, the both systolic and diastolic BP was taken by auscultatory method. The appearance of sound (phase-1 of the Korotkoff sound) recorded as systolic BP and disappearance of this sound (phase-5 of Korotkoff sound) was recorded as diastolic BP.[12,16]

Recording of Pulse

The pulse was recorded with the applying the tip of the fingers in the radial groove over the radial artery and the subjects forearm being semipronated and the wrist was slightly flexed.

The pulse rate was counted after sometimes so that any quickening produce due to nervousness of the subject get subsided and the pulse resumed its normal rate. The pulse rate was counted for complete 1 min.[16]

Statistical Analysis

Two tail Student's *t*-test was done using the standard formulas. The $P < 0.05$ was taken as statistically significant.

RESULTS

Initially, out of 60 volunteers, 25 volunteers were hyperreactive to cold pressor test, after 3 months of Ujjayi Pranayama they reduced to 11. However, the remaining subjects also reduce their reactivity to cold stress (Table 1).

Table 1: Distribution of subjects according to sex and age (n=60)

Sex	Age	Number of subjects	Total subjects	Percentage
Male	18-20	11	35	58.33
	21-24	22		
	25-27	02		
Female	18-20	20	25	41.66
	21-24	04		
	25-27	01		

BP

The mean systolic BP decreased from 121.32 ± 7.50 mmHg to 116.56 ± 6.50 mmHg after 3 months of Ujjayi Pranayama. The diastolic BP was found in the study to change from 78.82 ± 4.60 mmHg to 75.36 ± 5.0 mmHg. Average rise in systolic BP, due to cold pressor test, initially was 21.42 ± 6.5 mmHg, and this rise reduced to 18.36 ± 5.10 mmHg. While the rise in diastolic BP initially was 12.58 ± 4.60 mm Hg and this reduced to 10.16 ± 4.20 mmHg, which is statistically significant (Table 2).

Pulse Rate and Respiratory Rate

Pulse rate decreases from mean value of 82.40 ± 3.2 to 75.84 ± 2.65 and respiratory rate decreases from mean value 21.5 ± 1.6 per min to 18 ± 1.55 per min, which is statistically significant (Table 3).

DISCUSSION

In our study, cardiovascular autonomic function tests were carried out before and after 3 months of regular practice of "Ujjayi Pranayama." This showed a significant decrease in the heart rate, respiration rate, and the BP. The volunteers after practicing Pranayama showed autonomic equilibrium between sympathetic and parasympathetic nervous system.

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.[17,18]

We found that hyperreactivity to the cold pressor test reduced by doing regular Ujjayi Pranayama for 3 months. Furthermore, there was a further reduction in mean systolic and diastolic BP which was statistically significant. The reason for this can be parasympathetic dominance on autonomic activity which has been given in numerous studies, which was supported by the findings of a study which was conducted by Pramanik et al.[19,20]

Many studies have showed a beneficial effect of Pranayama on BP.[21-24] Pal et al. have explained this is due to increased parasympathetic activity.[11]

Lathadevi et al., also showed that a Pranayama training of 6 weeks duration produced a decrease in the basal sympathetic tone and an increase in the basal parasympathetic activity.[25]

Meditation ensures better peripheral circulation was reported by Bhargava et al.[8] and blood flow to the tissues reported by Gopal et al.[26]

Table 2: Changes in BP in mmHg during cold pressor test in hyperreactors before and after 3 months of Ujjayi Pranayama

Parameters	Mean±SD		Difference between initial and final mean	*P* value
	Before Pranayama	After 3 months of Pranayama	Mean value	
BP (mmHg)				
Basal BP				
Systolic	121.32±7.50	116.56±6.50	4.76	*P*<0.001
Diastolic	78.82±4.60	75.36±5.0	3.46	*P*<0.005
BP after hand dip in 40°C water for 1 min				
Systolic	140.76±9.60	135.88±8.76	4.88	*P*<0.001
Diastolic	89.82±5.90	85.67±6.85	4.15	*P*<0.005
Rise in BP due to cold stress				
Systolic	21.42±6.5	18.36±5.10	2.09	*P*<0.05
Diastolic	12.58±4.60	10.16±4.20	2.42	*P*<0.05

SD: Standard deviation, BP: Blood pressure

Table 3: Comparison of pulse rate and respiratory rate in the hyperreactor subjects before and after Ujjayi Pranayama

Parameters	Mean±SD		Difference between initial and final mean value	*P* value
	Before Pranayama	After 3 months of Pranayama		
Pulse rate (per min)	82.40±3.2	75.84±2.65	6.56	*P*<0.0001
Respiratory rate (per min)	21.5±1.6	18.0±1.55	3.5	*P*<0.0001

SD: Standard deviation

Raghuraj et al. have studied the acute effect of fast and slow Pranayamas on the heart rate variability,[27] while Telles and Desiraju have demonstrated the heart rate changes during the performance of different Pranayamas.[28] Patel and North also reported a decrease in the BP in hypertensive patients who were trained in the yoga relaxation methods.[29]

Nagendra et al. were also observed significant reduction in resting HR indicates a relaxed state of physiology and increased mental alertness and increased parasympathetic activity.[30]

Our study did not match with Tomar and Neelima, they were observed that there was no significance difference in resting respiratory rate, BP but there was significant difference in resting heart rate and resting pulse rate.[31]

Udupa et al. not found significant decrease in pulse rate they found from 65.20 ± 6.90 per min to 65.40 ± 2.90 per min after practicing the Pranayama for 6 months.[32]

The Sanskrit word "Ujjayi Pranayama" means victorious breath. The prefix, "ud" means upward or expanding and "jayi" means conquest or success. Pranayama makes the person concentrate on the process of breathing, and it destresses him. This may decrease the release of adrenaline, i.e., decrease the sympathetic activity, and hence, it may decrease the heart rate and the BP.[33]

During voluntary expiration, the intrathoracic pressure increases and blood from the lungs is squeezed into the heart, leading to an increase in the stroke volume; the baroreceptors in the carotid sinus experience more pressure and they discharge more. The increased baroreceptor discharge inhibits the tonic discharge of the vasoconstrictor nerves and it excites the vagus innervations of the heart, thus producing vasodilatation, a drop in BP and bradycardia.[34]

CONCLUSIONS

We can conclude that the regular practices of Ujjayi Pranayama for three months significantly decrease the stress induced changes in cardiorespiratory parameters and may cause shift of autonomic nervous control toward parasympathetic side which causes decreases the BP and heart rate and respiratory rate. Today yoga is being a subject of varied interest, gained world popularity. Recent research trends have shown that it can serve as an applied science in a number of fields such as education, physical education and sports, health and family welfare, psychology and medicine also one of the valuable means for the development of human resources for the better performance and productivity, however, their exist controversy in accepting yoga as medicine and therapy because it generally been believed that yoga is a spiritual science having emancipation as its goal and hence cannot be treated only as a therapy. Yoga has its own way of strengthening the weak part of the body.

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