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ORIGINAL ARTICLE

EFFECT OF PRANAYAMA ON BLOOD PRESSURE AND HEART RATE IN HYPERREACTOR TO COLD PRESSOR TEST

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ABSTRACT: INTRODUCTION: Stress is a dangerous and significant problem of World, which affects physical, mental, behavioral, and emotional health. Yoga has been reported to control stress, to be beneficial in treating stress related disorders, improving autonomic functions, lower blood pressure, increase strength and flexibility of muscles, improve the sense of well-being, slow ageing process, control breathing, reducing signs of oxidative stress and improving spiritual growth. **AIMS:** The aim of present study was to investigate whether regular practice of Yoga for three months can reduce the cardiovascular hyper-reactivity induced by cold pressor test. **MATERIALS AND METHODS:** The study group comprised 62 healthy male subjects of 17-27 years age group. Initially there were 30 hyper reactors to cold pressor test. The hyper-reactivity of 23 volunteers converted to hypo-reactivity after the yoga therapy of three months (76.66%). Other parameters like basal blood pressure, rise in blood pressure, pulse rate and rate of respiration were also statistically significantly reduced (by using student 't' test). **STATISTICAL ANALYSIS:** 2 tail student't' test was done by using the standard formulas. **RESULTS:** Regular practice of yoga significantly reduces the cardiovascular hyper-reactivity in basal blood pressure, rise in blood pressure after one minute of cold stress, heart rate, and rate of respiration, after three month of yoga practice. **CONCLUSION:** Regular practice of yoga for three months reduced the cardiovascular hyper-reactivity to cold pressor test in subjects, who were hyper reactive to cold stress, possibly by inducing parasympathetic predominance and cortico-hypothalamomedullary inhibition.

KEYWORDS: Yoga, Bhastrika Pranayama, Cold pressor test, Healthy male population.

INTRODUCTION: Studies by many workers have demonstrated that the systolic blood pressure is variable and changes in it are seen in response to many forms of stimuli such as excitement, exercise,[5,25] pain,[21] Yoga,[7,25] cold etc, but in comparison the yoga is more effective than the exercise.[25]

Cold Pressor Test as a standard stimulus to study the vasomotor response was introduced in 1932 (Hines and Brown 1932). The subjects who showed greater response in his study were called HYPER-REACTORS. It was suggested by them that some of these hyper-reactors may possibly be candidates for hypertension in future.[6] Yoga was found to have a considerable effect on different physical efficiencies of human being (Gopal et al 1973, Nayar et al 1975).

Lots of diseases occur due to stress in a modern society.[2,13] Hypertension is one of the commonest stress-induced cardiovascular disorder, posing a major public health challenge to population in socioeconomic and epidemiological transition.[10, 27] Relief of stress and regular aerobic exercise are employed as general non drug therapeutic intervention in all patients with hypertension.[9,24,34] In the study of hypertension, cold pressor test, introduced by Hines and Brown[10,11] was employed to measure the cardiovascular reactivity.[14,18] The persons hyper-reactive to cold pressor test are susceptible for early onset of hypertension.[12,14,15,17,20,36,39]

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We tested whether regular practice of Bhastrika pranayama for 3 months can reduce the cardiovascular hyper-reactivity, as the pranayama had good benefits on cardiorespiratory system of human body.[1,3,29,30,32,37]

MATERIAL AND METHOD: The present study "Effect of Pranayama on Blood Pressure and Heart Rate in Hyper reactor to Cold Pressor Test" was carried out in the department of physiology Gold Field Medical College, Chhainsa (H.R.), after consent from the Institutional Ethical Committee.

30 young medical student aged 17-27 years who were hyperreactors to cold pressor test participated in the study. They were included in the study to perform "Bhastrika Pranayama" for the duration of the three month and each subject served as its own control. Each subject under went through a detailed history and clinical examination with the following criteria:

Inclusion Criteria:

1. Healthy, nonsmoker, with no cardio-respiratory disorders.
2. Subject not doing any type of physical exercise.

Exclusion Criteria:

1. Subject were taking other physical activity like Gym, athletics etc.
2. Subjects who are smokers, alcoholic, hypersensitivity, respiratory disorder, Diabetes Mellitus or any disease related with cardio-respiratory system.

Cold Pressor Test: For cold pressor test technique of Hines and Brown (1936) was followed exactly.[9,11]

Technique of Test:

1. The subject ware allowed to take rest in supine position in a quite room maintaining the temperature 25-30°C for 20-30 minutes after that several reading of blood pressure were taken until a basal level was attained approximately.
2. With the subject still in supine position and with cuff of sphygomomanometer 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 blood pressure were taken at the end of 30 and 60 seconds. The highest of these two reading was noted as an index of the response.[27]
3. The hand was removed from ice water after sixty second, reading had been taken and then the reading were taken every two minutes until the blood pressure returned to its previous basal level.
4. On the basis of the observation as changes in blood pressure the subject were divided into two groups- depending on their response to cold stress (Hines and Brown 1936).[9, 11]

A- Hyper-Reactor: Those subjects in whom the systolic blood pressure rise more than 20 mmHg and or diastolic blood pressure more than 15 mmHg or cross the ceiling value of systolic blood pressure more than 145 mmHg and diastolic more then 95 mmHg.

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B- Hyporeactors or Normoreactors: Those subjects in whom the systolic blood pressure rise did not exceed 20 mmHg and diastolic 15 mmHg.

Method for Practicing Bhastrika Pranayama:

1. The subject were asked to sit comfortably in any suitable meditation posture with the head, erect and both hands on their knee in a peaceful area, and well ventilated room with soft lightning and favorable temperature.
2. Breath in and out forcefully, without taking strain.
3. The abdomen should expand and contract rhythmically with the breath in pumping action.
4. After taking about 10 such respirations, take deep inspiration followed by breath holding for while, then exhale forcefully through both nostril.
5. It completes one round and take short rest in each round.
6. Start such breathing exercise with the slow rate and then gradually increase the rate over long practice.
7. Do not expand the chest or raise the shoulder and body should not jerk.

Measurement of Blood Pressure: A mercurial sphygmomanometer was used to record the blood pressure: 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 minutes in a quiet room.

After taking the rough systolic blood pressure by palpatory method, the both systolic and diastolic blood pressure was taken by auscultatory method. The appearance of sound [phase-1 of the Korotk off] recorded as systolic blood pressure and disappearance of this sound [phase-5 of Korotk off sound] was recorded as diastolic blood pressure.[18,22]

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 pronated 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 one minute.[18]

DISCUSSION:

Reactivity to Cold Pressor Test: Studies by many authors have demonstrated that systemic blood pressure is variable and reacts to many forms of stimuli such as excitement, pain, cold, heat, and exercise.[28, 33] Many normal young people may develop essential hypertension in future. With application of standard stimuli to such person and observing the response, it might be possible to differentiate a group in which an abnormally great reaction, resulted from such type of stimulus.

In the present study we used cold water (4^0C) application to hand as a standard stimulus, introduced by Hines and Brown (1936).[9,11]

In the present study basal systolic blood pressure in 62 subjects was observed varying between 100 to 140 mmHg with a mean value of 119.93 $\pm$ 7.5 mmHg. The corresponding figures for diastolic blood pressure were observed to be 66 to 90 mmHg with mean value of 77.29 $\pm$ 5.24.

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On application of cold pressor stimuli for 60 second in entire series of 62 subjects on average rise of systolic blood pressure was 12.4±4.82 mmHg and for diastolic blood pressure it was 4.6±4.54 mmHg.

Hines and Brown (1936), has also observed a rise in response to cold application by 12.9±0.87 mmHg and 11.8±0.82 mmHg respectively in systolic and diastolic blood pressure.[9,11]

According to criteria laid down by Hines (1936) the subject were divided in to two group i.e. hyporeactor [showing rise not more than 20 mmHg for systolic B.P. and/or 15 mmHg of diastolic blood pressure and hyperreactor [showing increase rise than above].[9,11]

Hines and Brown later on modified the old criteria of hyperreactor and gave 'new' definition of hyperreactor and those having a rise of 15 mmHg diastolic or greater and a maximal basal diastolic pressure exceeding 90 mmHg.[9, 11]

In the present study about 48% subjects found to be hyper reactors and 52% as hypo reactors, as per the criteria laid down by Hines and Brown.[9,11]

Wirch, Jennifer L. Wolfe, Larry A et al (2006) divided hyper reactor in two groups designated as systolic and diastolic hyper reactors on the basis of increase in blood pressure, in systolic hyperreactors.[38]

Systolic blood pressure rise more than 20 mmHg while diastolic B.P. may increase more than 15 mmHg or not. In diastolic hyper reactor systolic blood pressure rise not more than 20 mmHg while in rise in diastolic B.P. is always more than 15 mmHg.

In the present study systolic hyper reactor were found showing greater rise in systolic blood pressure. The mean rise was 24.72±4.4 mmHg and 12.63±5.55 mmHg in systolic and diastolic blood pressure respectively. Our value correlate with Hines and Brown (1936) observed a rise of 29.4±4.2 and 24.5±2.6 in systolic and diastolic blood pressure respectively.[9,11]

In present study diastolic hyper reactor showing greater rise in diastolic blood pressure. The mean value of rise in blood pressure was 16.25±6.36 and 18±4.30 in systolic and diastolic blood pressure respectively. In the present study hypo reactors subjects showing mean rise in systolic and diastolic blood pressure was 13.6±3.6 and 10.66±2.5 mmHg respectively.

Our value correlate with- Hines and Browm (1936) observed on average systolic rise 11.4 mmHg and average diastolic rise 10.6 mmHg.[9,11]

Heart Rate: In the present study heart rate was calculated by R.R. interval of E.C.G. initially, the heart rate of the subjects was found to be in the range of 60-100 per minute, average heart rate 82.06 with standard deviation 3.75 after 3 months of Pranayama, decrease in the average heart rate, was 78.23±2.38 per minute which is significant ($p<.05$).

These finding correlate with:

1. Bowman, A.J., R.H. Claton et al (1997) They found significant decrease in heart rate, the initial heart rate 69±8 per minute which decreased to 61±7 per minute with p-value <.05 which is statistically significant.[4]
2. Madan Mohan, U.C. Rai, V. Balavittal (1983) – They found significant decrease in heart rate, initially the heart rate was 82±8.66 per minute which decreased to 76±6.4 per minute with p value <.05 which is statistically significant.[16]

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Pulse Rate: In the present study, the pulse rate of subjects initially were 81.23 per minute with S.D. 3.86 after 3 months of pranayama, the pulse rate changed to 78.16 per minute with S.D. 3.75 these finding were correlate with the following studies:

1. U.S. Ray, S. Mukhopadhyaya (2001), They found significant decrease in pulse rate initially it was 82.04±6.4 per minute, which decreased to 76.32±5.2 per minute with p value <.1 which is significant.[24]
2. Trans M.D. Holly R.G. (2001) also found significant decrease in the pulse rate. The initial pulse rate was 80.26±3.1 per minute and it decrease to 77.52±4.6 per minute after practicing pranayama for 3 months.[33]
3. Udupa K.N. et al (1975) not found significant decrease in pulse rate they found from 65.20±6.90 per minute to 65.40±2.90 per minute after practicing the pranayama for 6 months.[35]

The decrease in heart rate and pulse rate was probably due to increased vagal tone together with decreased sympathetic discharges without shifting autonomic balance.[5, 7, 19, 26] The decreased sympathetic discharge to the skeletal muscle vasculature may allow significant vasodilation to improve peripheral circulation.[31]

Blood Pressure: Initially, the mean systolic blood pressure of subject was 121.33 ± 10.3 mmHg which decreased after 3 months to 120.93 ± 9.01 mmHg with P value 0.022 which is significant. The diastolic blood pressure was 78.26±7.42 mmHg and after 3 months decreased to 78.2±7.40 mmHg with significant p value.022.

There finding correlate with Rashmi V., Dixit N., (2003) who also observed significant decreased in diastolic blood pressure.[23] Initially diastolic blood pressure was 74.80±4.32 mmHg which significantly decreased to 70.02±3.16 mmHg with significant p value (p<.04). Similar finding were also seen in following study.

Udupa K.N. (1975) found significant increase in systolic blood pressure and diastolic blood pressure after 3 months of pranayama they found initially mean systolic blood pressure 104.60±3.60 mmHg which increased to 106.00±7.30 mmHg and initial mean diastolic blood pressure was 87.80±1.80 mmHg, which increased to 89.00±1.00mmHg, with p <.001 which is significant.[35]

Gopal K.S. (1973) found significant decrease in B.P. with initial mean value of S.B.P. 109 ± 6.36 mmHg which decreased to 108 ± 80 mmHg after practicing yoga.[8] The D.B.P. was 79 ± 5.4 mmHg and after practicing pranayama, the D.B.P. decreased to 70.6 ± 6.49 mmHg with P < 0.001 which is significant.

RESULT: The present study was conducted on 62 male subjects of whom 30 were hyper reactor to cold pressor test (CPT).

These 30 hyper reactors were having mean heart rate of 82.06±3.75 and pulse rate of 81.23±3.86. This study shows that 3months pranayama significantly (p=0.048) decreases the heart rate to 78.23±33.96 and also significantly (p=0.016) decreases the pulse rate to 78.16±33.96 (Table: 5).

On the other hand 3 months pranayama shows a significant (p=0.22) decrease in both the basal systolic and diastolic blood pressure, respectively from 121.33±10.3mmHg and 78.26±7.42mmHg to 120.93±9.014mmHg and 78.2±7.40mmHg (Table: 6). On application of CPT the systolic and diastolic blood pressure shows an increased value, respectively as 142.44±6.6mmHg and

92.06±4.2mmHg, but the 3 months pranayama significantly ($p<0.05$) decreases the values to 136.86±6.4mmHg and 88.13±5.8mmHg.

STATISTICAL ANALYSIS: 2 tail student't test was done by using the standard formulas. The p-value less than 0.05 were taken as statistically significant.

CONCLUSION: The pranayama techniques like – Bhastrika pranayama may cause shift of autonomic nervous control toward parasympathetic side which decreases the blood pressure and heart rate. So it may cause shifting of hyper reactivity to C.P.T. to normal reactivity. Thus, in the present study out of 30 hyper reactor subjects 23 become hypo reactor after 3 months of regular pranayama practice.

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Category	Total Subjects	Percentage
Hypo-reactors	32	51.61%
Hyper-reactor	30	48.38%

Table 1: No. of Hyper-reactor Subjects. Out of 62 subjects, 30 subjects were hyper-reactor to Cold Pressor Test

In present study, the age of subject was in the rage of 17-27 years. Most of the subjects belonged to age group 17-20 years followed by 21-24 years.

Total subject = 62 Mean age = 21.4

Sl. No.	Age (Yrs)	No. of Cases	Percentage
1	17-20	33	53.22
2	21-24	24	38.70
3	25-27	05	8

Table 2: Distribution of subjects according to age

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Sl. No.	Subjects	Blood Pressure	Mean Value	S.D.	Rise in B.P. due to cold stress	Mean value	S.D.
1	Entire Series (62)	Systolic	119.93 (110-140)	7.5	Systolic	12.4 (8-30)	4.82
		Diastolic	77.29 (66-90)	5.24	Diastolic	11.6 (6-22)	4.54
2	Hyper-reactor (30)	Systolic	121.33 (110-140)	10.2	Systolic	22.66 (10-30)	6.4
		Diastolic	74.26 (66-90)	7.4	Diastolic	13.8 (06-22)	5.05
3	Systolic Hyper- reactor (22)	Systolic	122.09 (116-140)	13.43	Systolic	27.72 (22-30)	4.44
		Diastolic	73.54 (66-88)	10.12	Diastolic	12.63 (6-22)	5.55
4	diastolic Hyper- reactor (08)	Systolic	119.25 (110-136)	10.34	Systolic	16.25 (10-20)	6.36
		Diastolic	76.25 (70-90)	9.79	Diastolic	18.0 (16-22)	4.30
5	Hypo reactor (32)	Systolic	120.13 (116-142)	8.7	Systolic	13.6 (8-20)	3.6
		Diastolic	78.53 (60-88)	5.8	Diastolic	10.66 (8-14)	2.5

Table 3: Table showing effect of cold stress on basal blood pressure in mmHg with their mean value and standard deviation

Out of 62 male subject, 30 subjects were hyper-reactor To CPT

Sl. No.	Type of Hyper Reactor	No. of Hyper Reactor	Percentage
1	Total Hyper-reactor	30	48.0
2	Systolic hyper-reactor	22	35
3	Diastolic hyper-reactor	08	12

Table 4: Incidence of Hyper reactivity

Note: Out of 30 Hyper-reactors 06 subjects were found to have hyperreactivity to systolic as well as diastolic blood pressure.

Sl. No.	Parameters	Before Pranayama		After 3 months of Pranayama		Difference between initial and final mean value	P Value
		Mean Value	S. D.	Mean Value	S. D.		
1	Heart rate (per min) as calculated by R-R interval of ECG	82.06	3.75	78.23	33.96	3.83	0.048(<.05) (Significant)
2	Pulse rate (per min)	81.23	3.86	78.16	33.96	3.07	0.016(<.05) (Significant)

Table 5: Table showing comparison of various Parameter (Heart rate, Pulse rate and Respiratory rate) in hyper reactor subject before and after Pranayama

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Sl. No.	Parameters		Before pranayama		After 3 months of pranayama		Difference between initial and final mean value	P Value
			Mean Value	S. D.	Mean Value	S. D.		
1	Basal B.P. (mmHg)	Sys.	121.33	10.2	120.93	9.014	0.4	Significant (p<.05)
		Dias.	78.26	7.42	78.2	7.40	0.06	Significant (p<.05)
2	B.P. after hand dip in 4^0C water for 1 min	Sys.	142.4	6.6	136.86	6.4	5.54	Significant (p<.05)
		Dias.	92.06	4.2	88.13	5.8	3.93	Significant (p<.05)
3	Increase in B.P. (mmHg)	Sys.	22.66	2.79	15.86	1.57	6.80	Significant (p<.05)
		Dias.	13.8	1.3	9.93	.17	3.87	Significant (p<.05)

Table 6: Table showing changes in blood pressure in mm of Hg during Cold Pressor Test in Hyper-reactors before and after three months of Pranayama

Table 7: Table showing comparison of reactivity to Cold Pressor Test before and after three months of Pranayama (n=30)

After three months of pranayama out of 30 hyper reactors subjects 23 become hypo reactor while in other 7 subject reactivity did not change to C.P.T.

Sl. No.	Parameter	Reactivity to CPT before Pranayama	Reactivity to CPT after 3 months of Pranayama	Percentage
1	Hyper-reactor	30	07	76.66
2	Hypo-reactor	00	23	23.34

Table 7

RECORDING OF BLOOD PRESSURE:

FIG. 1

FIG. 2

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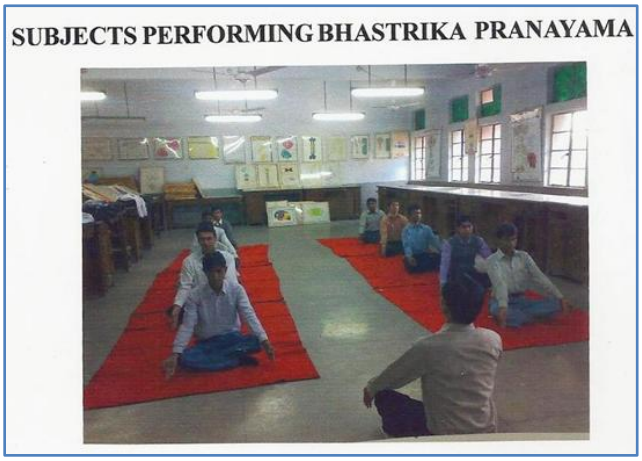

FIG. 3

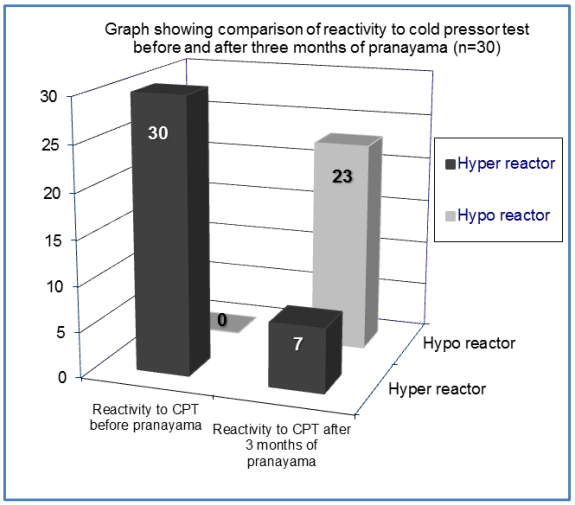

FIG. 4

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