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Added effect of pranayama with aerobic exercises for reducing blood pressure in pre hypertensives

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Abstract
Introduction: High blood pressure is a major cause for cardiovascular diseases. Thus pre hypertensive individuals should be prevented from worsening to hypertensive state. It has been found aerobic exercises has an effect on cardiovascular parameters. Also Prāṇāyāma has an important role in reducing blood pressure as well as regulating cardiovascular parameters.
Aim: To study the added effect of Prāṇāyāma with aerobic exercises for reducing blood pressure in pre hypertensives.
Materials and Methodology: Twenty four pre hypertensive individuals participated in the study. They were randomly divided into group a and group B. Group A included both aerobic exercises as well as Prāṇāyāma for 6 weeks and group b included only aerobic exercises. Informed consent was taken. In Prāṇāyāma individuals were asked to perform four types of Prāṇāyāma- alternate nostril yoga breathing, Praṇava Prāṇāyāma, Kapālabhāti, Bhrāmarī Prāṇāyāma for 30 minutes. While in aerobic exercises individuals were asked to do treadmill walking, stationary cycle, cross trainer. Blood pressure was taken using omron bp machine after each session of Prāṇāyāma as well as aerobic exercises.
Results: Blood pressure was significantly reduced in both the groups but when comparison was made between the two groups, group A was better than group B.

Keywords: prāṇāyāma, pre hypertensive, omron Bp machine

Introduction

The major cause of mortality and morbidity in patients with hypertension are cardiovascular diseases [1]. Hypertension is reported to be the 4th cause of death in developed countries and 7th in developing countries. The prevalence is rapidly increasing in developing countries and is one of the leading cause death and disability in developing countries [1] Blood pressure is a powerful cardiovascular risk factor which has an effect on the arterial wall and is responsible in part for various cardiovascular events such as cerebro-vascular accidents and ischemic heart diseases.

Blood pressure (BP) is the pressure exerted by circulating blood on the walls of the arteries also defined as the arterial pressure in the systemic circulation.

Hypertension (HTN) also known as high blood pressure or arterial hypertension is a chronic medical condition in which the BP is consistently elevated [2, 4].

In hypertension, the structure, mechanical behavior and function of vessels are affected, with a reduction in lumen diameter and thickening of the tunica media (structural change), increased vascular stiffness (mechanical change), and impaired NO-dependent vasodilatation (functional change) [6] Hypertension has been reported to be responsible for 57% of all stroke deaths and 24% of CVA deaths [1]. Each heart beat consist of a contraction and relaxation phase along with the pressure exerted against the vessel walls known as blood pressure which is usually taken at a brachial artery with a BP cuff and a sphygmomanometer which measures two basic pressures in the arteries:

1. Systolic pressure: It represents the maximum pressure exerted on the arteries when ventricles are in systole or contracted state. The normal range 90-120mmHg.
2. Diastolic pressure: It represents the minimum pressure in the arteries i.e. when the ventricles are in a relaxed state and ranges from 60-80mmHg.

Classification by American heart association (AHA) scientific sessions 2017 [8]

Table 1

Systolic	Diastolic	2017 ACC/AHA
<120	<80	Normal blood pressure
120-129	<80	Elevated blood pressure
130-139	80-89	Stage 1 hypertension
140-159	90-99	Stage 2 hypertension
>160	>100	Stage 2 hypertension

Pre hypertension: pre hypertension also known as high normal blood pressure, is an American medical classification for cases where person's blood pressure is elevated above normal, but not to the level considered hypertension i.e.
Systolic: 120-129 mm of Hg
Diastolic: <80 mm of Hg

Pre hypertension evidences early signs of functional or structural changes in heart and small arteries and include

individuals with multiple cardiovascular risk factors and early diseases marker but no evidence of target organ damage[2] and is associated with reduced conduit artery endothelial function and perturbation of oxidant/antioxidant status [7]. Pre hypertension is asymptomatic often at the time of diagnosis, however elevated blood pressure in rare can cause headache, visual changes, fatigue or dizziness [3]. Pre hypertension is a precursor of clinical hypertension and is closely related with increased incidence of cardiovascular disease [3].

- **Epidemiology**

The NHANES (national health and nutrition examination survey) estimates the prevalence of pre hypertension to be 36.3% all over the world which is seen higher in men than in women. The prevalence of pre hypertension in India was found to be 45% (29% women and 34%men) [2-4].

- **Diagnosis**

According to joint national committee (jnc8) pre hypertension is diagnosed if a person has 2 or more readings of above normal blood pressure in atleast one or several weeks [2, 3].

- **Risk factors**

The primary risk factors for pre hypertension is: Overweight
Other risk factors include:

- A sedentary lifestyle
- Age
- High BMI
- A high sodium intake
- Smoking
- Diabetes mellitus
- Excessive alcohol intake
- Low consumption of legumes fruits of vegetables. (<400g/day)
- Central obesity
- Increased waist hip ratio
- Use of oral contraceptives among women
- Family history of hypertension
- High levels of cholesterols and lipids

- **Prognosis**

The National Heart, Lung and Blood Institute suggest that people with pre hypertension are at a higher risk of developing hypertension compared to those with normal blood pressure.
A pre hypertensive person is 3times more likely to have heart attack and 1.7 times more likely to have heart disease than a person with normal blood pressure.
Pre hypertension also increases the risk of stroke.
Pre hypertension is a warning sign that the person may get high blood pressure in near future and to lower the risk of pre hypertension developing to hypertension, lifestyle modification and behavior is necessary [2-5].
With the new advents of treating medical conditions, exercises add as an added beneficial effect for treatment of HTN.
Exercise training is a well known form of preventing or reducing cardiovascular disturbances.
Regular exercises or physical activities is considered cornerstone in the prevention and management of hypertension as it promotes numerous cardiovascular and muscular adjustments that are antihypertensive and also epidemiological studies indicate that greater physical activity is associated with lower blood pressure [9-10].
It is able to prevent or reduces the vascular changes that are precursors of high blood pressure, such as diminishes nitric oxide availability and increased oxidative stress thereby controlling high blood pressure [7, 10].

Aerobic Exercise

The American College of Sports Medicine(ACSM) defines aerobic exercise as any activity that uses large muscle groups, can be maintained continuously and in rhythmic in nature [11]. As the name implies, muscle groups activated by this type of exercise rely on aerobic metabolism to extract energy in the form of adenosine tri phosphate (ATP) from amino acids, carbohydrates and fatty acids.

Prāṇāyāma

Out of many etiologies for development of hypertension, stress has been found a major culprit for it. Stress management might be helpful in control and prevention of high blood pressure. Various techniques of yoga and meditation have been improved beneficial for stress management and therefore, must be beneficial in prevention of developing hypertension from pre hypertensive state. They may bring the person from pre hypertensive to normo-tensive [12-14].
Yoga modulates autonomic activities by various mechanisms and action on hypothalamic limbic system, adrenal gland, and other organs of body. Studies have shown evidence for relationship between chronic stress, alterations in hypothalamic-pituitary adrenal axis activity and hypertension [15-18].

- **Alternate nostril breathing:** Also called alternate-nostril yoga breathing (ANYB) is a type of Prāṇāyāma that involves left nostril inhalation followed by right nostril exhalation and then right nostril inhalation followed by left nostril exhalation [19].
- **Praṇava Yoga:** Praṇava yoga is one of the simplest yogic exercise. It involves continuous chanting of word aum. It is relaxing in nature and relaxes the body very quickly. Vibrations produced Aum chanting also bring about positive changes in the brain leading to relaxation [20].
- **Kapālabhāti:** Kapālabhāti is a kriya or cleansing technique mentioned in hatha yoga pradipika. It is supposed to shine the forehead. In contrast to deep breathing relaxation exercises of Prāṇāyāma, Kapālabhāti involves very fast respiration at 120 respiratory strokes/min during the exercises which are obviously shallow in nature [21, 22].
- **Bhrāmarī Prāṇāyāma:** It is done in any comfortable posture and subjects are asked to inhale and exhale through nostrils and deeply. While exhaling, subjects need to produce sound (humming sound) like bumble bee strictly through nasal airways, keeping oral cavity closed by lips, ears closed by fingers [23].

Materials and methodology

Study Design: Experimental study
Sampling Technique: Simple random sampling
Settings: Bhausaheb Sardesai Talegaon Rural Hospital
Sample Size: 24(group A=12; group B=12)

Materials
- Mat
- Omron BP machine
- Assessment form
- Karvonen's formula
- Consent form
- Pen and paper
- Chair
- Treadmill
- Stationary cycle
- Cross trainer

Inclusion Criteria
- Diagnosed Pre hypertensive patients
- Both males and females
- Age-18 years
- No significant musculoskeletal problems

Exclusion criteria
- Uncontrolled HTN
- Acute myocardial infarction
- Other cardiac or pulmonary disease
- Balance impairement
- Low IQ
- Neurological involvement
- Not willing to participate
- Pregnant women
- Recent abdominal surgery

Methodology
- 80 subjects above 18 years of age were screened for pre hypertension using omron device.
- Subjects lying in pre hypertensive range two or more times in one week on alternate days were diagnosed as pre hypertensive (according to AHA criteria)
- 28 were diagnosed pre hypertensive and were randomly divided into two groups-group A group B (n=14) randomly using chit method. Two subjects from the group A and two subjects from group B had dropped out after two weeks and three weeks respectively.
- Written consent was taken from subjects.
- Group A patients were given aerobic exercises and Prāṇāyāma thrice a week.
- In aerobic exercises patients were asked to do treadmill, cycling and cross trainer starting with 20 minutes in first week going upto 60 minutes in last week [29]. Intensity was calculated using karvoven's formula.

Table 2

	Day 1		Day 2		Day 3	
Week	**time**	**Intensity**	**Time**	**Intensity**	**Time**	**intensity**
1	20	40	20	40	30	50
2	30	50	30	50	35	60
3	35	60	40	65	40	65
4	45	65	45	70	45	70
5	50	70	50	70	55	70
6	55	70	60	70	60	70

In Prāṇāyāma subjects were asked to perform four types of Prāṇāyāma

1. Alternate nostril yoga breathing (ANYB)-It involves inhalation through left nostril followed by exhalation through right nostril and vice versa [19].
   It was done for 5minutes.
2. Praṇava Prāṇāyāma-it involves continuous chanting of Aum [20].
   It was done for 3-5 minutes.
3. Kapālabhāti - it involves very fast respiration at 120respiratory strokes/minute during exercises [21, 22]. It was done only for a minute.
4. Bhrāmarī Prāṇāyāma- it involves inhalation through both nostrils and producing humming sounds of bee while exhaling [30]. Subjects were also asked to close their ear with thumb and eyes with their fingers. It was done for 2-3 minutes.

- Aerobic exercises were done y both the groups thrice a week for 6weeks.

Result and Discussion

On applying paired t test the pre and post systolic values of group A gave a mean difference of 11.5 with p value of 0.0001 which is extremely statistically significant.

Pre and post diastolic values of group A gave a mean difference of 14 with p value 0.0001 which is extremely statistically significant.

After applying paired t test, the pre and post systolic values of group B gave a mean difference of 4.166 and p value is 0.0098 which is considered to be very statistically significant.

The pre and post diastolic values of group B gave a mean difference of 7.833 and p value is 0.0003 which is statistically extremely significant.

On applying unpaired t test between the groups, the systolic pressure of the group A reduced by 11.5mm of Hg with a p value of 0.0001 which is statistically extremely significant and that of group B reduced by 4.166mm of Hg with a p value of 0.0098 which is very statistically significant.

The diastolic pressure of group A reduced by 14mm of Hg with p value of 0.0001 which is statistically extremely significant and that of group B reduced by 7.833mm of Hg with p value of 0.0003 which also statistically extremely significant.

Discussion

In the current experimental study, 24 pre hypertensive subjects (according to AHA) were randomly divided into two groups of 12 each in group A and group B. The group A was put on 6 week of Prāṇāyāma along with aerobic exercises (thrice a week for 60 minutes), whereas group B was just put on

aerobic exercises program which include cycling, treadmill walking, and cross trainer (20 minutes to 60 minutes from week 1 to week 6) The results obtained after 6 weeks was that there was pronounced reduction in BP of both the groups. But when both the groups were compared, results showed that group A is more effective than group B. There was a reduction in both systolic and diastolic pressures of group A; systolic pressure reduced by 11.5mm Hg and diastolic pressure reduced by 14mmHg with p value of 0.0001 for both systolic as well as diastolic which is considered extremely significant. On the other hand for group B; the systolic pressure showed reduction by 4.166mmHg and diastolic pressure reduced by 7.833mmHg with p value of 0.0098 and 0.0003 respectively. Exercise promotes numerous cardiovascular and muscular adjustment that are anti hypertensive. These adjustments depend on the amount of ET, which is determined by volume (training time), intensity (degree of training load)and frequency of ET(number of training sessions at any given time) [31].

Exercise Promotes

- Physiological cardiac hypertrophy [32]
- Reduction in systolic blood pressure (SBP) and heart rate (both at rest and submaximal loads) [33, 34]
- Increases lumen diameter of coronary arteries and cardiac blood flow [35]
- Increases the circulating NO [36]
- Corrects the peripheral capillary rarefaction in hypertensive animals [34]
- Promotes revascularization [37]
- Reduces peripheral vascular resistance
- Exercise training also promotes important metabolic adaptations that reflect on blood pressure control, e.g. reduction in plasma triglycerides and low density lipoproteins.
- Increased insulin sensitivity in tissues [38]
- During exercise, the sympathetic nervous system is activated and cause the release of epinephrine and nor epinephrine and as a result HR increases. An immediate effect of exercise on HR, thus results in an increase in HR as a exercise intensity increases.
- When the work load at sub maximal intensity is held constant HR will also plateau and ready a steady state HR, indicating the optimal HR for meeting circulatory demands at that specific work rate. When exercise bout is finished, the increased HR does not instantly returns to its resting rate. Endurance training increases parasympathetic activity and decreases sympathetic activity at rest, thus the more conditioned an individual is, the lower his/her resting HR would be and HR will recover more rapidly following exercise, due to enhanced parasympathetic activity. Sub maximal exercise for a given work rate will also result in reduced HR due to reduced sympathetic activity to the heart [39].

Regulation of blood pressure is normally involuntary process which is controlled by sympathetic nervous system. Cerebral cortex can be trained to influence the blood pressure. This effect is likely to be mediated through hypothalamus. Hypothalamus is closely related to limbic system which plays important role in emotional and instinctive behavior. Stress too is likely to influence blood pressure through the same pathways. Since the cerebral cortex is necessary for all voluntary actions, the voluntary reduction of stress may be achieved by training cerebral cortex [40]. Yogic exercises involves physical, mental and spiritual task in comprehensive manner. Yoga also involves Prāṇāyāma i.e. voluntary alteration of breathing pattern and scientist working on yoga found increased parasympathetic tone in yoga practioners especially trained in Prāṇāyāma [40]. In patients with hypertension [41] practice of Prāṇāyāma has shown to produce better control of blood pressure [41]. It is shown that regular practice of Prāṇāyāma reduces the sympathetic tone within a period as short as 7 days [42]. Alternate nostril yoga breathing- it involves inhalation through one nostril followed by exhalation through other nostril. A significant reduction in heart rate, systolic blood pressure, diastolic blood pressure with hypertension [43] and significant increase in parasympathetic activity during [44] and after ANYB [45] was reported. Praṇava Prāṇāyāma- slow and deep yogic breathing techniques which has shown to be effective in reducing heart rate, systolic blood pressure and diastolic blood pressure in hypertension patients within five minutes of practice. It was said to be due to normalization of autonomic cardiovascular rhythm as a result of increased vagal modulation and/ or decreased sympathetic activity along with an augmentation of endogenous nitric oxide production [46] Kapālabhāti Prāṇāyāma- it is said to increase sympathetic tone during the exercises, but final after effect of exercises is reduced sympathetic activity or increase in vagal tone [47] Bhrāmarī Prāṇāyāma- it involves inhalation through both nostril and producing humming sound of bee while exhaling [48] Five minutes of slow paced Bhrāmarī Prāṇāyāma have been reported to influence parasympathetic dominance on cardiovascular system due to its effects in reducing systolic blood pressure, diastolic blood ressure, mean arterial blood pressure and heart rate [49] Jerath *et al*. hypothesize that the voluntary slow deep breathing functionally resets the ANS through stretch induced inhibitory signals and hyperpolarization currents propogated through both neural and non-neural tissues which synchronizes neural elements in heart, lungs, limbic system and cortex. During inspiration, stretching of lung tissue produces inhibitory signals by action of slowly adapting stretch receptors (SARs) and hyper polarization current by action of fibroblast. Both inhibitory impulses and hyper polarization current are known to synchronize neural elements leading to the modulation of nervous system and decreased metabolic activity indicative of parasympathetic state [50]. Another study reported that Prāṇāyāmaa practices increase the frequency and duration of inhibitory neural impulses by activating pulmonary stretch receptors during and above tidal volume inhalation as in Hering Bruer reflex, which brings about withdrawal of sympathetic tone in skeletal muscle blood vessels, leading to widespread vasodilatation, thus causing decrease in peripheral resistance and thus decreasing the BP. After hyoscine –N-butylbromide, the parasympathetic blocker, it was observed that blood pressure was not significantly as a result of Prāṇāyāmaa, as it was observed when no drug was administerd. Thus this indicated the parasympathetic

activation during the practice of Prāṇāyāmaa [51].
Thus this may be the mechanism for reduction of blood pressure in the above study.

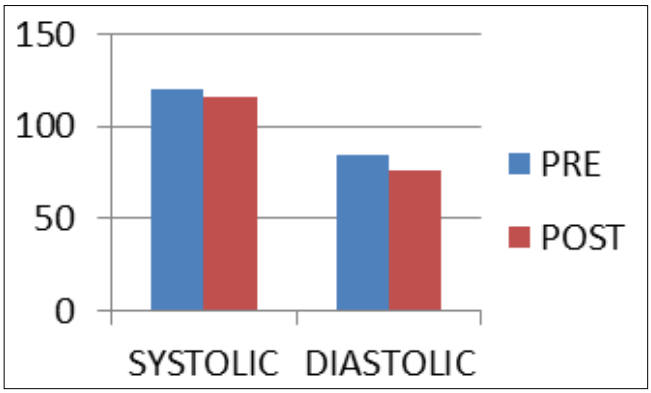

Fig 1: Group A

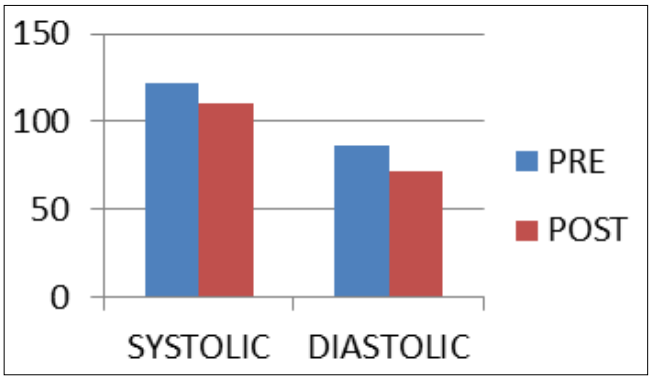

Fig 2: Group B

Table 3

	Mean	SD	P value	T value	Significance
PRE	121.666	8.319	0.0001	5.6596	Extremely significant
POST	110.166	9.290			

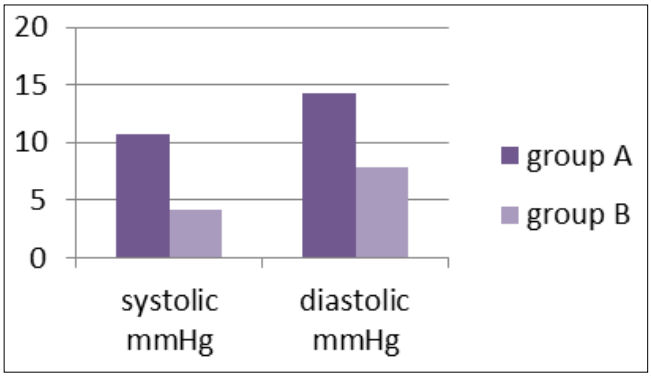

Fig 2

Diastolic

Table 4

	Mean	SD	P value	T value	Significance
PRE	86.166	4.431	0.0001	8.2082	Extremely significant
POST	72.166	4.929			

Group B

Systolic

Table 5

	Mean	SD	P value	T value	Significance
PRE	120.333	8.439	0.0098	3.1184	Significant
POST	116.166	7.071			

Diastolic

Table 6

	Mean	SD	P value	T value	Significance
PRE	84	7.092	0.0003	5.1989	Extremely significant
POST	76.166	5.257			

On comparing both groups
Systolic

Table 7

	Mean difference	P value	T value	Significance
Group A	11.5	0.0001	2.8179	Statistically Significant
Group B	4.166	0.0098		

Diastolic

Table 8

	Mean difference	P value	T value	Significance
Group A	14	0.0001	2.9284	Statistically Significant
Group B	7.833	0.0003		

Conclusion

The study concluded that Prāṇāyāma have an added effect along with aerobic exercises to reduce blood pressure in pre hypertensive patients.

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