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ACUTE EFFECT OF SLOW ABDOMINAL BREATHING ON HEART RATE VARIABILITY IN PRE-HYPERTENSIVE

Clinical Research

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ABSTRACT

The study observes the effect of slow abdominal breathing on blood pressure (BP) and relate these changes to Heart Rate Variability (HRV) in prehypertensives.22 self- controlled prehypertensive volunteers were subjected to intervention of slow abdominal breathing @ of 6 breaths/min and record the ECG using standardized procedure for HRV analysis along with the systolic (SBP) and diasolic (DBP)blood pressure during their pre intervention period[@ of 20 breaths/min] ,the intervention period & post intervention period [@ of 20 breaths/min] . Recorded data in three stages were analysed using paired "t" test and Pearson test for correlation with a "p" value of <0.05 as level of significance. The study observed a marked decrease in mean SBP & DBP (P =0.001) in addition to significant decrease in mean sympathetic activity (L.F.) & increase in parasympathetic activity(H.F) (P value <0.05) during slow abdominal breathing @ 6 breaths/min from the pre intervention period @ 20 breaths /min in pre hypertensives subjects . Later on increasing the breathing rate to @ 20 breaths /min from 6 breaths/min showed a significant reversal of the values of HRV parameters, SBP and DBP in the period of post intervention. Negative though non-significant relation was observed between blood pressure reduction and change in vagal tone (HF). Slow abdominal breathing at 6 breath /min acutely decreases the SBP and DBP in prehypertensive which may be due to increase in the vagal tone[HF] with decreases in the excitability in sympathetic system[LF,LF/HF] .

KEYWORDS

INTRODUCTION

Pre-hypertension as defined by JNC seventh report [1] is indeed a precursor of hypertension, with a conversion rate over the period of 4 years of about 30%, and is associated with an increased risk of major cardiovascular diseases [2,3].

Prevalence of pre-hypertension is continuously on a rise (47.4%) globally and is attributed to autonomic dysfunction being both a reason and consequence of hypertension[4]. Both sympathetic over activity and vagal withdrawal contributes to pre hypertension in Indian population [5], with vagal withdrawal being a prominent cause in males[6].

Currently several lifestyle modifications are being used globally as a non pharmacological method to reduce high blood pressure that includes de-stress programs like meditation and other stress management technique[7,8]. Stress management practices have been reported to reduce BP and multiple cardiovascular risk factors in several studies[9,10].

The beneficial effect of slow abdominal breathing /Diaphragmatic breathing has been seen in chronic obstructive diseases & hypertension [10]by several investigators. Respiration being under both voluntary and involuntary control can be varied voluntarily as per the need and from person to person. Diaphragmatic breathing is one of the most useful stress reduction techniques and consists of a slower respiration rate (<8) with large tidal volume inhalation and abdominal contraction during exhalation. Since the respiratory sinus arrhythmia is increased and is in phase with the breathing pattern this approach evokes an alternative for control of autonomic nervous system.

Studies indicate that Diaphragmatic breathing increases Heart rate variability (HRV) in normal & patients of heart failure as well as it reduces related pathological symptoms [11]. Recent evidence also suggests lowering of Blood pressure in mild & moderate hypertensive following slow abdominal breathing [12], but very few studies have seen its effect on pre hypertensive [13]. Due to paucity of data on use of non-pharmacologic breathing techniques in blood pressure reduction, the study will approach to assess effectiveness of slow abdominal breathing and quantify the change in blood pressure in prehypertensive.

MATERIAL AND METHODS

After approval from the institutional ethical committee the study was conducted at department of Physiology of HIMS, Swami Rama Himalayan University ,Dehradun with the hypothesis that voluntary slow deep breathing functionally resets the Autonomic nervous system by neural impulses from the lungs hence is likely to elicits vagal predominance like states decreasing the blood pressure.

It was an experimental self control trial to examine the effect of slow abdominal breathing on vagal tone in young adults and hence reduction in blood pressure.

Sample Size & Sampling :

Based on the sample size calculation for this experimental design with effect size of 0.17 at alpha error of 0.05 , power of 80% & pooled SD of 0.13 [14] **a** total of 22 volunteers of age group 20-40 years were included after a written informed consent.

The participants were recruited from students & resident population at SRHU campus, Dehradun using the following inclusion & exclusion criteria.

Inclusion criteria:

Pre Hypertensive according to WHO/JNC VII classification[1] with mean systolic BP between 120- 139mm Hg and/or a diastolic BP between 80- 89 mm Hg and not on antihypertensive medication.

Exclusion criteria included :

Hypertension (BP≥140/90 mm Hg), secondary hypertension, Clinical cardiovascular disease, stroke ,Diabetes (fasting plasma glucose ≥126 mg/dl) ,Chronic Renal Disease, Current use of anti-diabetic medications or insulin, Heavy alcohol consumption, Current use of a low sodium salt in diet

Study Protocol -

The study population was screened for blood pressure as per the standardised protocol of JNC 7 and those diagnosed as pre hypertensive were recruited for the study. After fulfilling the inclusion and exclusion criteria the volunteers were called at the Department in the morning and administered pre formed questionnaire for recording of demographic and anthropometric data. Volunteers were than subjected to recoding of resting heart rate, respiratory rate, and ECG.

Each subject was informed about the interventional protocol and it`s methodology to allay their anxiety.

Experimental protocol-

1. PRE INTERVENTION- parameters observed are -

- Resting pulse rate
- Respiratory rate.
- Basal blood pressure
- Vagal Tone – following a rest of 10minutes volunteer were asked to perform slow abdomina breathing at the rate of 20 breaths/minute for 10 minutes duration using a visual meterome & manually under supervision and ECG was recorded during last 5

min of the supervised breathing. Subjects were allowed to adjust the tidal volume.
- Blood pressure during breathing

2. INTERVENTION- parameters observed are-
- Resting pulse rate
- Respiratory rate.
- Vagal Tone - following a rest of 10minutes volunteer were asked to perform slow abdominal breathing at the rate of 6 breaths/minute for 10 minutes duration using a visual metronome & manually under supervision and ECG was recorded during last 5 min of the supervised breathing.
- Blood Pressure during breathing

3. POST INTERVENTION-
- Resting pulse rate
- Blood pressure:
- Vagal tone- following a rest of 10minutes volunteer were asked to perform slow abdominal
- breathing at the rate of 6 breaths/minute for 10 minutes duration using a visual metronome & manually under supervision and ECG was recorded during last 5 min of the supervised breathing. Subjects were allowed to adjust the tidal volume.
- Blood Pressure during breathing

Experimental Session)	Pre-Intervention	Intervention	Post-Intervention
Volunteers-	Ctrl Breathing @20 breaths/minute	Slow abdominal Breathing @6 breaths/minute	Ctrl breathing @20 breaths/minute
Parameters	PR,RR,HRV,BP	PR,RR,HRV,BP	PR,RR HRV,BP
Time (min)	10	10	10

DATA ANALYSIS-

The data was analysed using SPSS Software version 20. Data is presented as mean /SD for quantitative variables like blood pressure, % body fat and parameters of HRV. Differences across the groups i.e. pre intervention, intervention & post intervention was analysed using analysis of variance with repeated measures and by paired "t" test. Probability was set at less than 0.05 as significant.

RESULTS:

22 self- controlled prehypertensive volunteers were subjected to the slow abdominal breathing at the rate of 6 breaths/min and heart rate variability was recorded using standardized procedure during the intervention along with the blood pressure to assess the acute change in both systolic and diastolic blood pressure from their pre intervention period.

Table 1. Demographic , anthropometric parameters and cardio vascular parameters of volunteers(n=22)

Parameters	Values
Age (yrs)	28.32± 8.24
Height(cm)	171.55±7.2
Weight(Kg)	78.84± 14
BMI (Kg/m2)	25.7±2.1
Body Fat %	25.4±5.6
Pulse Rate (per min)	88.27±7.1
Respiratory rate(breaths/min)	17.23±1.5
Systolic blood Pressure(mmHg)	128.14±6.4
Diastolic Blood Pressure (mmHg)	80.64±4.6

Values in Mean±SD

Mean age of the volunteers in our study was 28.32±8.24 years with none of the volunteers included in my study being obese [BMI of 25.7±2.1 kg/m2]. During the study, the mean pulse rate and respiratory rate of the volunteers were estimated to be 88.27±7.1 breaths/min and 17.23±1.5 breaths/min respectively. The mean systolic and diastolic blood pressure was within limits of prehypertension.

TABLE 2. Blood Pressure Changes during breathing rate of 20 breath/min and 6 breath /min(n=22)

Pre-Intervention period with breathing rate @20 breath/min			
	Pre	Post	P- value
SBP(mmHg)	128.05± 6.3	127.23±8.9	0.49
DBP(mmHg)	80.36±4.3	80.23±4.3	0.85
Intervention period with breathing rate @6 breath/min			
	Pre	Post	
SBP(mmHg)	125.45±9.5	118.73±6.2	0.001
DBP(mmHg)	79.86±4.4	75.5±4.3	0.001
Post-Intervention period with breathing rate @20 breath/min			
	Pre	Post	
SBP(mmHg)	125.09±9.1	125.82±11.08	0.422
DBP(mmHg)	80.09±4.5	80.41±4.7	0.69

Values as Mean±SD; Paired "t" test

During the 1st intervention with breathing at the rate of 20 breaths/min there was decrease in the SBP but the fall was insignificant . No change in the mean value of DBP was observed following the intervention. (P value >0.05).When the intervention was changed to 6 breaths/min, there was marked decrease in SBP [125.4 vs 118.7mmHg] and the fall was statistically significant (p=0.001). A significant decrease in DBP was also observed(P =0.001).When the volunteers were again shifted to breath at 20 breaths per minute no change in the pre and post SBP & DBP was observed.

TABLE 3.Autonomic function assessment during the study protocol in the volunteers(n=22)

	PreIntervention @20 breath /min	Intervention @6 breath /min	Post-Intervention @20 breath /min
LF(n.u)	66.72±13.4	46.39±19.2##	65.31±18.3*
HF(n.u)	32.84±13.2	53.6±19.2##	34.71±18.2*
LF/HF Ratio	2.64±1.4	0.99±0.61##	2.76±1.6**

*Values in Mean ± SD; Paired "t" test: Between 1 & 2: # p=<0.01; ##p=<0.001; between 2& 3 *p=<0.01; **p=<0.001; between 3&1 $*

When the breathing rate of the volunteers were changed from 20 breaths/min to 6 breaths/min(between intervention 1 and 2) there was a marked significant decrease in sympathetic activity (L.F.) with a marked & significant rise in parasympathetic activity(H.F) (P value <0.05) . A significant decrease in LF/HF ratio was observed . On reversal of the breathing rate from 6 breath/min to 20 breath/min the converse to the above was observed with a significant rise in sympathetic activity(L.F.) &a significant decrease in parasympathetic activity(H.F.) (P value <0.05) with a significant increase in their ratio. On comparing between intervention 1 and 3, there was neither a significant change in sympathetic activity nor parasympathetic activity was observed (P value>0.05).

Analysing for correlation of the change in blood pressure and change in sympathetic and vagal tone observed weak but positive & negative relationship correspondingly. The breathing rate shift from 20 breath/min to 6 breath/min definitely brought down the LF and raised the HF but it was not related to the change in blood pressure with LF & HF and the changes in blood pressure.

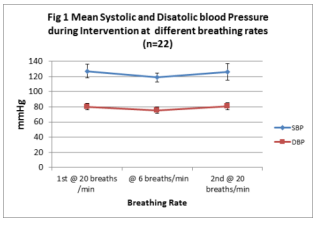

Fig 1. It was observed that on shifting the breathing rate from 20 breath/min to 6 breadth/min there was a significant fall in systolic as well as in DBP. On again changing the breathing rate to 20 breadths/min, there was significant rise in both systolic as well as DBP.

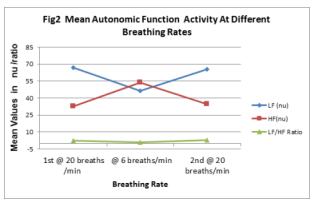

Fig2. It was observed that on changing the breathing rate from 20 breaths/min to 6 breaths/min there was marked and significant fall in sympathetic activity (L.F.) in contrast to marked and significant rise in

parasympathetic activity (H.F.).On again changing the breathing rate to 20 breaths/min there was marked and significant increase in sympathetic activity with decrease in parasympathetic activity. Reciprocal changes were change observed in ratio of L.F. and H.F. during the change in the intervention.

DISCUSSION

High blood pressure is a known risk factor for cardiovascular diseases with several recent studies suggesting that prehypertensives are also at greater risk for developing both the above comorbidities.[3]

Prehypertension regarded as normal blood pressure is cross sectionally associated with subclinical atherosclerosis and target organ damage [15] with it being an important risk factor for the above cause it is essential to find non-pharmacological methods to decrease the blood pressure in early stage. The present study observed the acute effect of slow controlled breathing @ of 6 breaths/ min on the SBP and DBP and its association with the change in heart rate variability. We observed a significant fall in both SBP and DBP during a controlled breathing @6 breath/min. Breathing at a higher rate of 20 breath /min did not observe the fall in both the pressures. Similar acute effect of the slow controlled breathing was observed by Wang et al[13] in their study on post-menopausal women and the effect continued for a period of 6 months. Our results are also similar to study by Joseph et al[11] which observed a fall in blood pressure immediately after the slow controlled breathing but in contrast to our study the intervention trial observed a stronger effect of slow breathing over fast breathing in reduction of blood pressure. Our results are also similar to study by Pinheiro CH et al[16]which observed modulation in CVS including a fall in SBP ,DBP & MAP after a slow breathing training in essential hypertension subjects[16].Several studies have observed a significant fall in blood pressure[S/D: 5.5/3.5 mmHg] in mild hypertensives by using a device guided breathing for a period of 2 weeks[17] .Cardiovascular parameters recorded during the slow breathing for 10min resulted in significant fall in SBP, DBP and Heart rate even in a single session but in hypertensive receiving antihypertensive and those un medicated[18] by Kaushik et al . An study using controlled breathing in form of such pranayama @ 6 breath/min also reduced the Heart rate and caused significant fall in SBP, pulse pressure but a insignificant fall in DBP in hypertensive's which was related to increased vagal modulation and /or decreased sympathetic activity and improved baroreflex sensitivity[19].

However there was dissimilarity of our work with the work done by Altena et al which observed that slow abdominal breathing relaxation only had a relative long-term effect on the SBP, but no remarkable effect on SBP in the follow-up, and also has no significant effect on the diastolic pressure[20]. Another study also observed a significant fall in SBP in prehypertensive women following slow breathing but had no effect on DBP[13]

The mechanism by which slow abdominal breathing reduces blood pressure was observed using the HRV analyses that reflect cardiac autonomic nervous function which could be the potential mechanism underlying the BP changes. Our study observed that the parasympathetic drive was enhanced with a corresponding fall in sympathetic (LF) when volunteers were asked to breath from 20 breath/min to slow controlled breathing @6 breath /min (Fig2). The change in sympathetic and parasympathetic drive due to change in breathing pattern showed much similar results with the work reported by Joseph et al[21] and Bernardi et al[22] as the possible mechanism of reduction in blood pressure.

Such change in the autonomic function tests using standing to lying ratio , hand grip and 30:15 ratio was also observed by study conducted by Mourya M on subjects with stage 1 hypertension following slow breathing exercises[23] .Results of our study is also strengthened by the study in which controlled breathing caused a decrease in low frequency variation and LF/HF variation in normotensives and hypertensive although the LF fall was less in hypertensive, but the LF/HF ratio decreased more in them suggestive of a higher rise in HF variation of R-R interval[24].

The mechanism behind reducing blood pressure by changing vagal tone through slow abdominal breathing in pre hypertensives may be by improving arterial baroreflex sensitivity ,reducing sympathetic activity and reducing chemoreflex sensitivity (deriving from the activation of the Hering-Breuer reflex induced by the increased tidal volume), which in turn enhances the baroreflex sensitivity. Consistent with other non-pharmacological intervention to lower the BP in hypertensive, slow abdominal breathing can effectively reduce BP in those suffering from prehypertension possibly by increasing the excitability of the vagus Nerve and reducing the excitability of sympathetic nerves. Slow abdominal breathing @6 breaths /min alters the autonomic activity of body by increasing parasympathetic activity(HF)and decreasing sympathetic (LF) simultaneously which is reflected as fall in SBP and DBP both in pre hypertensive.

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