DOPPLER EVALUATION OF COMMON CAROTID ARTERY HAEMODYNAMIC PARAMETERS IN PATIENTS WITH ESSENTIAL HYPERTENSION AFTER ALTERNATE NOSTRIL BREATHING EXERCISES

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ABSTRACT

BACKGROUND
Essential hypertension is a well-known predictor for cardiovascular disease, and it is mainly characterized by increased activity of sympathetic nervous system. As breathing exercises were known to reduce blood pressure by modulating autonomic nervous system activity, the present study was done to confirm the sympathetic lowering effect of alternate nostril breathing exercises in patients with essential hypertension by studying the haemodynamic parameters of left common carotid artery. We wanted to measure and compare the immediate effect of 30 minutes of ANB exercises on left common carotid artery diameter, Peak Systolic Velocity (PSV) and Resistive Index (RI) in hypertensive subjects.

METHODS
40 hypertensives in the age group of 45-65 years of both the genders were recruited for this study. Study group involved 20 and the control group involved 20 hypertensive subjects. Diameter of left Common Carotid Artery (CCA), PSV & RI before and immediately after 30 minutes of ANB was assessed with Gray scale and Doppler ultrasound.

RESULTS
A significant increase in vessel diameter (p <0.056) and decrease in PSV (p <0.010), RI (p=0.008) was observed after ANB exercises in the study group. In the control group, no significant change in vessel diameter (p =0. 485), RI (p<=0.789) & PSV (p=0.777) was seen after 30 minutes.

CONCLUSIONS
Sympathetic lowering effect of ANB exercises was evidenced by increase in vessel diameter, decrease in RI & PSV.

KEYWORDS
Breathing Exercises, Carotid Artery, Hypertension.


BACKGROUND
In India, prevalence of hypertension is 25% in urban and 10% in rural population.1 Hypertension is associated with increased risk of cardiovascular mortalities and morbidities. It increases the incidence of stroke, heart failure and end stage renal disease. The commonest type of hypertension is essential/idiopathic hypertension which accounts for 95% cases of hypertension. It is also known as primary hypertension since the secondary causes of hypertension like renal or endocrine disorders are absent. Both genetic and environmental factors play an important role. Obesity, insulin resistance, stress, sedentary lifestyle, high alcohol intake, smoking, high salt intake, low potassium intake and aging are known risk factors for essential hypertension.2 Activation of sympathetic nervous system (SNS) seems to be the most important cause for essential hypertension.3 This enhanced sympathetic activation in hypertension contributes to hyperlipidaemia, insulin resistance and left ventricular hypertrophy resulting in long term complications.4 Increased sympathetic activity increases blood pressure by increasing cardiac output as well peripheral resistance, increasing renin secretion from JG cells and also by increasing sodium reabsorption from the kidney. Baroreceptors in carotid and aortic vessels were responsible for preventing rapid changes in blood pressure. Vagal tone of the heart is due to constant low firing rate of the baroreceptors, increasing the parasympathetic activity and decreasing sympathetic activity in normal young adults. Carotid artery thickness increases with aging which in turn decreases the vessel compliance thereby reducing baroreceptor sensitivity.5 Decreased baroreceptor activity increase sympathetic discharge. Long term pressure on the carotid vessels in hypertension also
decreases baroreceptor sensitivity reducing the sensitivity below the value of 7 ms/mmHg.\textsuperscript{6} The increased adrenergic drive may not only due to altered baroreceptor function, but also due to increased sensitivity of vascular chemoreceptors, and decreased parasympathetic activity.\textsuperscript{7} New ACC/AHA 2017 Hypertension Guidelines states that systolic blood pressure above 140 mmHg and diastolic blood pressure above 90 mmHg is considered as essential hypertension.\textsuperscript{8} Anti-hypertensive drugs prescribed to treat hypertension act by mainly modulating autonomic activity. Non-drug interventions like Yoga, meditation, breathing exercises and stress reducing techniques were suggested as additional interventions and various studies had proved that these techniques reduce blood pressure by modulating autonomic function. Alternate Nostril Breathing (ANB) exercises were known to reduce heart rate and blood pressure by decreasing sympathetic and increasing parasympathetic activity in hypertensive patients.\textsuperscript{9,10} In all these studies, changes in blood pressure was observed with direct measurement of systolic and diastolic blood pressure or with heart rate variability tests.\textsuperscript{11} No study was done so far to observe the effect of breathing exercises on changes in vessel haemodynamic parameters. Doppler ultrasound is a non-invasive, cheaper and faster technique commonly used to measure vessel blood flow and arterial stiffness. It is used to study peak systolic velocity (PSV), Vessel Diameter (VD), & Resistive Index (RI). PSV is an indirect measure of arterial stiffness. Normal PSV in common carotid artery (CCA) is more than 45 cms/sec. If it goes above 125 cms/s, it indicates definite stenosis. Normal value of RI in CCA is 0.72 and 0.84.\textsuperscript{12} RI indicates the resistance offered by the vessel to blood flow as well as vessel wall compliance. Resistive index is calculated using the formula $RI = \frac{PSV - EDV}{PSV}$ where EDV is End Diastolic Velocity.\textsuperscript{13} The normal value of vessel diameter of CCA is 6.5 mm &6.1 mm in males and females.\textsuperscript{14} The aim of the present study was to observe the immediate effect of ANB exercises on diameter and haemodynamic parameters in left common carotid artery.

**Aims and Objectives**

1. To measure and compare the haemodynamic parameters &Vessel diameter of left common carotid artery in control group before and after 30 minutes.
2. To measure and compare the immediate effect of Alternate Nostril Breathing (ANB) exercises on haemodynamic parameters & Vessel diameter of left common carotid artery in study group before and after 30 minutes.
3. To compare the parameters of left common carotid artery between study and control group.

**METHODS**

The present study was conducted in the Radiology department of a private medical college in Madurai after obtaining Institutional ethical committee clearance. Among the patients who had attended the General Medicine OP between July to November 2017, recently diagnosed hypertensive patients, not started on drugs but advised life style modifications were recruited for this study after obtaining their informed written consent. Forty subjects with essential hypertension in the age group of 45-65 years of both the genders were chosen by simple random sampling. The subjects were assigned as the study (Interventional) group (n=20) who practiced breathing exercises and control (Non-interventional) group (n=20) who do not do any breathing exercises, randomly by using a randomization sequence generated in Microsoft Excel. Subjects with Essential hypertension whose systolic BP is between 130-160 mmHg and diastolic BP between 86-98 mmHg (Prehypertension & Stage I hypertension) and who do not have previous exposure to breathing exercises were included in the study. Subjects with clinical evidence of any acute illness like upper and lower respiratory tract infection, coronary artery disease, diabetes, chronic renal diseases, malignancy, subjects on medication and who had undergone major surgery were excluded from the study.

**Data Collection Method and Tools**

Blood pressure was measured in the sitting posture using mercury sphygmomanometer (Diamond Agencies). Gray scale and Doppler ultrasound (GE Voluson P8) of left common carotid artery was done for the assessment of diameter of left common carotid artery and Doppler parameters like- Peak Systolic Velocity (PSV) and Resistive Index (RI). Proximal Left common carotid artery was imaged in the neck, using high frequency linear probe, without giving any probe pressure. Vessel Diameter (VD) was measured by placing the callipers in the outer wall and the vertical diameter was measured. On colour Doppler, the spectral waveform was obtained by placing the sample volume with the lumen of the vessel with standard Doppler angle of 60 degrees. Doppler parameters like PSV and RI were obtained from machine automated measurements based on auto or manual tracing of the spectral waveform. All the parameters were measured both before and after ANB exercise.
**Results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>64.2</td>
<td>64.1</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.8</td>
<td>7.1</td>
</tr>
<tr>
<td>Mean</td>
<td>57.1</td>
<td>57.2</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>12.7</td>
<td>12.8</td>
</tr>
</tbody>
</table>

**Table 1. Comparison of Baseline Values Between Interventional and Non-Interventional Group**

**Paired Samples Statistics**

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64.150</td>
<td>20</td>
<td>6.8000</td>
<td>1.5205</td>
<td>0.494</td>
</tr>
<tr>
<td>2</td>
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<td>20</td>
<td>7.0223</td>
<td>1.5702</td>
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</tr>
<tr>
<td>3</td>
<td>6.330</td>
<td>20</td>
<td>0.9257</td>
<td>0.2070</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.76</td>
<td>.65</td>
<td>.77</td>
<td>.09</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. Among Control Group Comparison of Values Before and After 30 Minutes**

**Table 3. Among Interventional Group Comparison of Values Before and After 30 Minutes**

<table>
<thead>
<tr>
<th>Left Common Carotid Artery</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV (cms/s) - Before</td>
<td>64.150</td>
<td>20</td>
<td>6.8000</td>
<td>1.5205</td>
<td>0.494</td>
</tr>
<tr>
<td>PSV (cms/s) - After</td>
<td>64.050</td>
<td>20</td>
<td>7.0223</td>
<td>1.5702</td>
<td></td>
</tr>
<tr>
<td>VD (mm) - Before</td>
<td>6.330</td>
<td>20</td>
<td>0.9257</td>
<td>0.2070</td>
<td></td>
</tr>
<tr>
<td>VD (mm) - After</td>
<td>.76</td>
<td>.65</td>
<td>.77</td>
<td>.09</td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

The present study results show that 30 minutes of ANB exercises significantly reduced common carotid artery PSV (P <0.010), increased vessel diameter (P<0.056) and decreased RI (P<0.008) in the study group (Table 3). This confirms the effect of ANB exercises in reducing blood pressure in hypertensive patients. Narrower the tube, the pressure wave will be faster in hypertensives.12 After ANB exercises, the mean PSV had decreased from 57 cms/s to 51 cms/s after ANB exercises in study group. Hence decrease in PSV is an indirect measure of decrease in arterial stiffness. The results of our study are in accordance with a study where a strong positive correlation was observed between systolic blood pressure and PSV between pressures of 135 and 160 mmHg and not below or above that in the left CCA.15 Carotid artery is an elastic artery and resistance in these vessels is mainly influenced by peripheral sympathetic nervous system.14 Excess activity of sympathetic nervous system in hypertension decreases Vessel diameter which leads to increase in peripheral resistance. This increased peripheral resistance along with decreased vessel compliance is responsible for increase in RI in hypertension. In the present study, VD had increased from the mean value of 6.620 to 6.789 mm in left CCA and RI had decreased from the mean value of 0.7665 to 0.6965. This confirms the sympathetic lowering effect of deep breathing exercises in hypertension. PSV, VD & RI almost remained the same before and after 30 minutes of rest in the control group. (Table 2). Hence an observable significant difference in parameters was noted between both the study and the control group. (Table 4) ANB exercises were shown to decrease blood pressure in hypertensives.9,10 Slow breathing at a rate of 6/min stimulates the pulmonary stretch receptors which in turn results in vasodilation by causing sympathetic withdrawal of blood vessels. This could also be due to increased baroreceptor sensitivity which in turn can increase the vagal discharge and decrease sympathetic activity.17 Improved endothelium dependant flow mediated vasodilation was also observed after breathing exercises in middle aged and older individuals and not in younger age group.18 The results of our study coincide with the results of previous studies which showed decrease in sympathetic activity in hypertensive patients after ANB.9,10,17,18

In our study, carotid artery was chosen for evaluation as arterial stiffening was found to be more in elastic arteries than muscular arteries with increasing age.19 Endothelium dependant NO production as well number of voltage gated calcium channels in vascular smooth muscle also decrease with age. Haemodynamic parameters of left common carotid artery were analysed and not the right, because left CCA arises directly from the aortic arch and has a considerable presence in thorax. The present study was done with only patients categorized as under Prehypertension & stage I hypertension since only in these groups, life style...
modifications advised are sufficient to reduce blood pressure without taking drugs. Pre-hypertension is characterized by systolic BP between 130-139 and diastolic BP between 80-89 and stage 1 Hypertension between 140-159 and 90-99 mmHg. We included only middle and old age hypertensive in our study as sympathetic nervous system activity increases with aging and change in arterial stiffness was adequate to obtain visible results.20

Strength of the study Doppler vessel parameters were recorded for the first time after ANB exercises. Limitation Future studies could be done on a larger sample size. The results measured were only temporary and to obtain consistent result, all the parameters could be measured after few months of breathing practice. Changes in muscular arteries could be recorded. The effects of ANB can also be studied in essential hypertensive on drug treatment.

CONCLUSIONS
Alternate nostril breathing exercises increase left common carotid artery peak systolic velocity, vessel diameter and decrease resistive index in patients with essential hypertension indicating a decrease in sympathetic activity. No significant change was observed in hypertensive patients who did not practice breathing exercises. ANB exercises could be practiced regularly along with other non-pharmacological interventions to decrease blood pressure as well as to reduce the drug dosage in patients who were already on drugs.

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REFERENCES