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RESEARCH ARTICLE

Impact of alternate nostril breathing exercises on vascular parameters in hypertensive patients - An interventional study

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ABSTRACT

Background: Hypertension is characterized by overactivity of sympathetic nervous system. Sympathetic activation increases blood pressure both by stimulating heart and blood vessels. Breathing exercises are known to balance the autonomic function. Previous studies on hypertensives had shown that alternate nostril breathing (ANB) exercises reduce sympathetic activity by decreasing systolic and diastolic pressure. Since the effect of ANB on blood vessels was not documented so far, the present study was done to confirm the sympathetic lowering effect of ANB on vessel wall parameters immediately after 30 min of ANB exercises. **Aims and Objectives:** This study aims to measure and compare the immediate effect of 30 min of ANB exercises on the left brachial artery diameter, peak systolic velocity (PSV), and resistive index (RI) in hypertensive subjects. **Materials and Methods:** A total of 40 hypertensive patients in the age group of 45–65 years of both the genders were recruited for this study. The study group (interventional) and the control group included 20 hypertensive subjects each. Gray scale and Doppler ultrasound of the left brachial artery were done to assess the diameter of arteries, PSV, and RI before and immediately after 30 min of ANB. **Results:** In the study group, significant increase in vessel diameter (VD) ($P < 0.001$), and decrease in PSV ($P = 0.040$), RI ($P < 0.001$) were observed after ANB exercises. In the control group, no significant change in VD ($P = 0.485$), RI ($P = 0.789$), and PSV ($P = 0.777$) was seen after 30 min. **Conclusion:** ANB exercises reduced sympathetic activity in hypertensive patients.

KEY WORDS: Breathing Exercises; Brachial Artery; Essential Hypertension

INTRODUCTION

The increased demand of the present modern lifestyle has induced a lot of stress and stress-related disorders in all age groups. Hypertension is one such condition prevalent worldwide, increasing the risk of cardiovascular mortalities, and morbidities such as myocardial infarction, heart failure, and stroke. 95% of cases of the hypertension come under essential hypertension and though it is said that the cause is unknown, it is attributed to environmental and genetic factors. In essential/primary/idiopathic hypertension, secondary causes of hypertension such as endocrine or renal are not present. According to new American College of Cardiology/American Heart Association 2017 Hypertension Guidelines, Prehypertension is characterized by systolic BP between 130 and 139 and diastolic BP between 80 and 89 and stage I Hypertension between 140 and 159 and 90–99 mmHg.[1]

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Known etiological factors for essential hypertension include obesity, insulin resistance, stress, sedentary lifestyle, high alcohol intake, smoking, high salt intake, and aging.[2,3] Most of these factors contribute to essential hypertension by overactivity of sympathetic nervous system (SNS). This increased adrenergic drive could be due to baroreceptor dysfunction, increased sensitivity of vascular chemoreceptors, and decreased parasympathetic activity.[4] The decrease in baroreceptor sensitivity is secondary to reduced vascular compliance or increased vasoconstriction.[5] Increased sympathetic activity increases vasoconstriction and decreased sympathetic activity results in vasodilation. Drugs prescribed to treat hypertension act by modulating autonomic activity. One of the non-pharmacological measures suggested to reduce sympathetic activity in hypertension is breathing practice. Breathing exercises are known to balance the autonomic function. Various studies had reported that alternate nostril breathing (ANB) exercises reduce heart rate and blood pressure by decreasing sympathetic and increasing parasympathetic activity. Deep breathing exercises decrease both systolic and diastolic blood pressure in hypertensive patients.[6-8]

Although the effect of 6-week yoga exercises and meditation on brachial artery reactivity is documented in a study on cardiovascular disease patients, the effect of breathing exercises alone on vascular parameter in hypertensive patients is so for not studied.[9] Doppler ultrasound is one of the standard non-invasive techniques used to measure vessel blood flow and arterial stiffness. The parameters that were measured commonly include peak systolic velocity (PSV), vessel diameter (VD) (DI), and resistive index (RI). PSV is used to measure arterial stiffness indirectly. Stiffer the tube, the pressure wave will be faster. RI indicates the resistance to blood flow as well as vessel wall extensibility. RI is calculated using the formula, RI = PSV-end diastolic velocity (EDV)/PSV, where EDV is EDV.[10] The aim of the present study was to confirm the sympathetic lowering effect of ANB exercises on vascular parameters before and immediately after 30 min of ANB exercises.

Objectives

The objectives of this study were as follows:

1. To measure and compare the vascular parameters of the left brachial artery in the control group before and after 30 min
2. To measure the immediate effect of ANB exercises on vascular parameters of the left brachial artery in the study group before and after 30 min
3. To compare the vascular parameters of the left brachial artery between the study and control group.

MATERIALS AND METHODS

The present study was conducted in the department of radiodiagnosis of a private medical college hospital in Madurai. 40 hypertensive subjects in the age group of 45–65 years of both the genders with mean systolic BP between 130 and 160 mmHg and diastolic BP between 86 and 106 mmHg attending general medicine operative between March and July 2017 were chosen by simple random sampling. 20 hypertensive subjects were assigned to the study (ANB) group who practiced ANB exercises and 20 to non-interventional (control) group who do not do any breathing exercise, randomly using a randomization sequence generated in Microsoft Excel. The study was conducted after getting clearance from the Institutional Ethical Committee.

Subjects with essential hypertension advised on lifestyle modification, who do not have prior exposure to pranayama/yoga and who gave their voluntary consent to participate were included in the study. Subjects with clinical evidence of any acute illness such as upper and lower respiratory tract infection, renal diseases, hormonal disorders, and subjects on medication and who had undergone major surgery were excluded.

Description of Intervention

On the day of the study, after obtaining informed consent from the subjects, baseline recording of blood pressure was done initially in the sitting position. Doppler parameters were then measured in the brachial artery for all the participants. The interventional group participants were then taught ANB exercises by a certified yoga instructor to familiarize them with the technique.

ANB involves inhalation through the left nostril for a count of 1–5 while the right nostril is occluded and exhalation through the right nostril for a count of 1–5 with the left nostril occluded with no pause in between. The same procedure is repeated in the right nostril again and completed in the left nostril. This completes one cycle. Hence, for 1 min, there will be 6 breathing cycles so that the respiratory rate could be maintained at 6/min. Once the skill is acquired, after 30 min of ANB exercise, Doppler values were then recorded for the interventional group. For the non-interventional group, Doppler values were assessed before and after 30 min of rest.

Data Collection Methods and Tools

Baseline data on all participants were collected using structured questionnaire. Blood pressure was measured using mercury sphygmomanometer (diamond). Gray scale and Doppler ultrasound (GE Voluson P8) of the left brachial were done for the assessment of the diameter of artery and Doppler parameters such as -PSV and RI. The left brachial artery was imaged in the cubital fossa using high-frequency linear probe, without giving any probe pressure. Brachial artery was chosen as it is easily accessible. VD was measured by placing the calipers in the outer wall and the vertical diameter was measured. On color Doppler, the spectral waveform was obtained by placing the sample volume with the lumen of the vessel with standard Doppler angle of 60°. Doppler parameters such as 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.

Statistics

The data were entered into MS Excel and analyzed using SPSS v16.0. The quantitative data were checked for normality and summarized using mean/median and standard deviation/interquartile range as appropriate. The change in readings within groups before and after intervention was analyzed using paired *t*-test (normal distribution of values). Between-group differences were analyzed using unpaired *t*-test. $P < 0.05$ was the cutoff to determine statistical significance.

RESULTS

According to Table 1, there was no significant difference in baseline values between the study and control group. Table 2 shows that there was no significant difference in Doppler parameters before and after 30 min in the control group. Table 3 shows that there was significant difference in all the Doppler parameters before and after 30 min of ANB exercises in the study group. Table 4 shows a significant difference in Doppler parameters between the control and study group.

Table 1: Comparison of baseline values between the study and control group

Brachial artery	Control	Study
	Mean±SD	Mean±SD
PSV (cm/s)	73.6±12.8	69.4±16.9
VD (mm)	4.0±0.6	3.9±0.6
RI	0.91±0.05	0.93±0.07

SD: Standard deviation, PSV: Peak systolic velocity, VD: Vessel diameter, RI: Resistive index

Table 2: Among the control group, comparison of before and after 30 min values

Paired samples statistics

Brachial artery	Mean	*n*	SD	Standard error mean	*P*
Pair 1					
PSV (cm/s) - before	73.600	20	12.7544	2.8520	0.777
PSV (cm/s) - after	73.645	20	12.5430	2.8047	
Pair 2					
VD (mm) - before	3.995	20	0.5680	0.1270	0.485
VD (mm) - after	3.984	20	0.5607	0.1254	
Pair 3					
RI - before	0.9130	20	0.04813	0.01076	0.789
RI - after	0.9125	20	0.04822	0.01078	

SD: Standard deviation, PSV: Peak systolic velocity, VD: Vessel diameter, RI: Resistive index

DISCUSSION

The present study results according to Table 3 show that 30 min of ANB exercises significantly reduced PSV ($P < 0.040$), increased VD ($P < 0.001$), and decreased RI ($P < 0.001$) in the study group. This confirms the effect of ANB exercises in reducing blood pressure in hypertensive patients. Increase in VD decreases the peripheral resistance which, in turn, decreases the blood pressure. As RI increases with increasing resistance in compliant vessels, decrease in RI indicates increase in vessel compliance.[11] In stenotic vessels, PSV increases through the area of narrowing depending on the diameter of narrowing.[12] Brachial artery is a muscular artery made up of many layers of the vascular smooth muscle cells and the tone of this vessel is mainly under the influence of SNS along with hormones such as NO and angiotensin II. The most commonly used parameter to assess the arterial stiffness is PSV. Brachial artery peak systolic velocities range between 50 and 100 cm/s (around

Table 3: Among the study group, comparison of values before and after 30 min of ANB

Brachial artery	Mean	*n*	SD	Standard error mean	*P*
Pair 1					
PSV (cm/s) - before	69.400	20	16.8879	3.7762	0.040
PSV (cm/s) - after	62.500	20	19.8667	4.4423	
Pair 2					
VD (mm) - before	3.905	20	0.5596	0.1251	<0.001
VD (mm) - after	4.261	20	0.6398	0.1431	
Pair 3					
RI - before	0.9340	20	0.06723	0.01503	<0.001
RI - after	0.8735	20	0.7876	0.01761	

SD: Standard deviation, PSV: Peak systolic velocity, VD: Vessel diameter, RI: Resistive index

Table 4: Comparison of difference in various parameters before and after intervention between the study and control group

Group statistics

Brachial artery	Study arm	*n*	Mean±SD	Standard error mean	*P*
PSV (cm/s)	Control	20	–0.0450±0.69998	0.15652	0.033
	Study	20	6.9000±13.97705	3.12536	
VD (mm)	Control	20	0.0115±0.07220	0.01615	<0.001
	Study	20	–0.3560±0.33401	0.07469	
RI	Control	20	0.0005±0.00826	0.00185	<0.001
	Study	20	0.0605±0.04763	0.01065	

SD: Standard deviation, PSV: Peak systolic velocity, VD: Vessel diameter, RI: Resistive index

60 cm/s). Stiffer the artery, higher will be the pulse wave velocity which increases the risk for disease.[13] In our study, after ANB exercises, PSV had decreased significantly. In the present study, subjects practiced breathing exercises only at a rate of only 6 breaths/min. This type of deep breathing, by stimulating the pulmonary stretch receptors, can result in sympathetic withdrawal of skeletal blood vessels resulting in widespread vasodilation. Decrease in blood pressure was also observed after breathing practices with a decrease in rate pressure product.[14,15] Blood vessels are under sympathetic tone. Breathing practice by reducing sympathetic overactivity would have dilated the brachial artery increasing VD. Baroreceptor insensitivity, leading to arterial stiffness, has been postulated to be the most important cause for essential hypertension. Deep breathing practices with equal inspiration and expiration were known to improve the baroreceptor sensitivity.[16]

The results of our study coincide with the results of the study which evaluated the effects of yogic intervention on brachial artery reactivity in coronary artery disease (CAD) patients.[9] Endothelium-dependent brachial vasodilatation was noticed after yoga and meditation only in CAD patients and not in those who do not have the disease. Another study had also reported an improved endothelium-dependent flow-mediated vasodilatation in brachial artery of only middle-aged and older individuals after yoga (along with breathing) practice and not in young individuals.[17] This study was done only on middle and older age group and not in younger individuals because in young age arterial wall stiffness may not be sufficient enough to change blood pressure as in old age.[18] With aging, there is increase in SNS activity. In essential hypertension, structural and functional changes occur in the blood vessels along with endothelial dysfunction and increased sympathetic activity, leading to arterial stiffness and raised PSV.[19] No significant change in parameters was observed in the control group after 30 min of rest [Tables 2 and 4]. Essential hypertensive patients alone were included in our study to rule out other medical causes. Recently diagnosed patients, not on drugs were included to avoid the impact of drugs on study results.

Strength of Study

This was the first study of its kind to assess the impact of breathing exercises alone on blood vessels in hypertensive subjects.

Limitation

The effect was of short term, and hence, long-term study must be planned to obtain stable results. Sample size could be increased and evaluation of other blood vessels could also be done in future studies.

CONCLUSION

ANB exercises reduced blood pressure in middle-aged and older hypertensives by increasing brachial VD, decreasing PSV, and RI when compared to the control group. This confirms the effect of ANB exercises in reducing the sympathetic overactivity by the parasympathomimetic effect. These simple, easy to learn breathing techniques could be practiced regularly to reduce the drug dosage as well to prevent the development of long-term complications of hypertension in future.

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REFERENCES

1. Pradhan A, Vishwakarma P. Decoding the 2017 hypertension guidelines: The ten commandments. Heart India 2017;5:139-44.
2. Carretero OA, Oparil S. Essential hypertension. Circulation 2000;101:329-35.
3. Kharde AL, Deshpande J, Phulambrikar R, Mahavarakar V. Prevalence of hypertension and its risk factors in a field practice area of tertiary care teaching hospital in rural area of western Maharashtra. Int J Med Sci Public Health 2018;7:6-79.
4. Verma N. Sympathetic nervous system and hypertension. Hypertens J 2017;3:27-36.
5. Carthy ER. Autonomic dysfunction in essential hypertension: A systematic review. Ann Med Surg 2012;3:2-7.
6. Pal GK, Velkumary S, Madanmohan. Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. Indian J Med Res 2004;120:115-21.
7. Janet KS, Gowri PM. Effectiveness of deep breathing exercises on blood pressure among patients with hypertension. Int J Pharm Bio Sci 2017;8:256-60.
8. Mourya M, Mahajan AS, Singh NP, Jain AK. Effect of slow- and fast-breathing exercises on autonomic functions in patients with essential hypertension. J Altern Complement Med 2009;15:711-7.
9. Sivasankaran S, Pollard-Quintner S, Sachdeva R, Pugeda J, Hoq SM, Zarich SW, *et al.* The effect of a six-week program of yoga and meditation on brachial artery reactivity: Do psychosocial interventions affect vascular tone? Clin Cardiol 2006;29:393-8.
10. Makwana MB, Mistri A, Patel VJ. Physiological assessment of common carotid artery resistive index to evaluate different risk factors for the development of cerebrovascular stroke. Int J Basic Appl Physiol 2017;6:727-41.

11. Bude RO, Rubin JM. Relationship between the resistive index and vascular compliance and resistance. Radiology 1999;211:411-7.
12. Donnelly R, Hinwood D, London NJ. ABC of arterial and venous disease. Non-invasive methods of arterial and venous assessment. BMJ 2000;320:698-701.
13. Jarhult SJ. Hyperemic Brachial Artery Blood flow Velocity. Digital Comprehensive Summaries of Uppasala Dissertations from the Faculty of Medicine. Uppasala: Acta Universitatis Upsaliensis; 2018. p. 620.
14. Pal GK, Agarwal A, Karthik S, Pal P, Nanda N. Slow yogic breathing through right and left nostril influences sympathovagal balance, heart rate variability, and cardiovascular risks in young adults. N Am J Med Sci 2014;6:145-51.
15. Goyal R, Lata H, Walia L, Narula MK. Effect of pranayama on rate pressure product in mild hypertensives. Int J Appl Basic Med Res 2014;4:67-71.
16. Joseph CN, Porta C, Casucci G, Casiraghi N, Maffeis M, Rossi M, *et al.* Slow breathing improves arterial baroreflex sensitivity and decreases blood pressure in essential hypertension. Hypertension 2005;46:714-8.
17. Hunter SD, Dhindsa MS, Cunningham E, Tarumi T, Alkatan M, Nualnim N, *et al.* The effect of bikram yoga on endothelial function in young and middle-aged and older adults. J Bodyw Mov Ther 2017;21:30-4.
18. Chen W, Li S, Fernandez C, Sun D, Lai CC, Zhang T, *et al.* Temporal relationship between elevated blood pressure and arterial stiffening among middle-aged black and white adults: The Bogalusa heart study. Am J Epidemiol 2016;183:599-608.
19. Jacobs DR Jr., Duprez DA, Shimbo D. Invited commentary: Hypertension and arterial stiffness origins remain a dilemma. Am J Epidemiol 2016;183:609-12.

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