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Blood pressure and purdue pegboard scores in individuals with hypertension after alternate nostril breathing, breath awareness, and no intervention

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Background: Previously alternate nostril yoga breathing (anuloma-viloma pranayama) was shown to reduce the blood pressure (BP) in people with hypertension. An elevated BP has been associated with poor performance in certain tasks requiring attention and co-ordination. The Purdue pegboard task assesses manual dexterity and eye-hand co-ordination.

Material/Methods: In the present study there were ninety participants with essential hypertension. Their ages ranged from 20 to 59 years (group average age \pm S.D., 49.7 \pm 9.5 years; sixty males). Participants were randomized as three groups, with thirty participants in each group. One group practiced alternate nostril yoga breathing for 10 minutes, the second group practiced breath awareness for the same duration and the third group was given a control intervention (i.e., reading a magazine with neutral content). Assessments were taken before and after the interventions for participants of the three groups. Assessments included the blood pressure and performance in the Purdue pegboard task. Data were analyzed with a repeated measures ANOVA and *post-hoc* analyses were Bonferroni adjusted.

Results: Following alternate nostril breathing (ANYB) there was a significant decrease in systolic and diastolic blood pressure ($p < 0.001$ and $p < 0.05$), and an improvement in Purdue pegboard task scores for both hands ($p < 0.05$), and for the right hand ($p < 0.001$). Breath awareness (the control session) also showed a significant decrease in systolic blood pressure ($p < 0.05$). The right hand scores improved in the group reading a magazine ($p < 0.05$).

Conclusions: The results suggest that the immediate effect of ANYB is to reduce the BP while improving the performing in a task requiring attention, bimanual dexterity and visuo-motor co-ordination.

key words:

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Background

The Purdue pegboard task is an indicator of fine motor speed and dexterity of the dominant hand, non-dominant hand and both hands simultaneously [1]. Since the task requires visuo-motor co-ordination it also requires a certain level of focused attention based on the study which follows [2]. This study investigated the relation between tests of manual dexterity and attentional functions in forty-nine normal, right-handed medical students, Purdue pegboard assembly subtest scores were weakly to moderately correlated with measures of tonic and phasic alertness and divided attention. Here tonic attention means general level of attention while phasic attention refers to moment-to-moment attention. The findings suggested the importance of attention as a determinant of performance in tasks for manual dexterity. The Purdue pegboard task has also been used to assess cortical processing speed [3]. It indirectly assesses attention since attention is one of the pre-requisites for co-ordinated, dexterous movements [4].

In a study which compared the performance of twenty people newly diagnosed with hypertension and twenty controls, in a neuropsychological battery, people with hypertension were significantly slower on the reaction time test and in the digit span forward task [5]. The results were interpreted as suggesting that arterial hypertension is associated with impaired vigilance and attention span. This task was selected as dexterity and co-ordination are required for most activities in daily life [6]. However to compare the results with earlier studies in people with normal BP, fifteen people with hypertension were also given the cancellation task.

The practice of yoga includes physical postures, regulated breathing, meditation and certain philosophical principals [7]. Regulated breathing or *pranayama* practice includes several techniques involving the regulation of the breath rate, the depth, the nostril through which the person breathes, and whether inhalation is through the mouth or nose [8].

Among the various yoga breathing techniques, alternate nostril yoga breathing (ANYB) has been specifically demonstrated to promote reduction of blood pressure. For example the systolic blood pressure and diastolic blood pressure decreased in twenty-one healthy male participants after practicing ANYB for thirty minutes, but not after other practices such as right or left nostril yoga breathing or breath awareness [9]. Also a significant reduction in heart rate and systolic blood pressure was found in ten participants who practiced a single session of ANYB for twenty minutes, while no change was found in two sets of controls who either relaxed on a couch or practiced quiet breathing with their eyes closed [10].

ANYB also favorably influenced the performance in a cancellation task [11]. The letter cancellation task assesses selective attention and concentration [12]. This suggests that ANYB may be useful in performing tasks which require attention. As was mentioned above in people with hypertension the ability to pay attention is affected. Also attention is associated with increased sympathetic nervous system activity [13] and hence an increase in blood pressure. In general, sympathetic activation is associated with all tasks which required attention.

Hence the present study was planned to assess the immediate effect of ten minutes of ANYB on the blood pressure and performance in the Purdue pegboard task. There were two controls. These were (i) breath awareness and (ii) sitting at ease reading a magazine. Breath awareness was selected as a control, for three reasons. Breath awareness is an important part of any yoga breathing technique. Also, awareness of the breath in practicing the Burmese Buddhist Vipassana meditation technique was found to be associated with vagal dominance [14]. Finally, breath awareness also improved the performance in a cancellation task which tests attention [15].

To summarize, the aims of the study were as follows (a) Previously, in separate studies in people with normal blood pressure ANYB improved the performance in an attention task, while in other volunteers the practice lowered the BP. (b) The two (BP, task performance) were not studied at the same time in one study, on people diagnosed with hypertension. (c) Hence the question was whether the practice of ANYB would help people with hypertension to improve their task performance (i.e., Purdue pegboard task and cancellation task in a smaller group) while maintaining their blood pressure levels.

Material and Methods

Participants

Ninety participants with essential hypertension diagnosed based on prevailing norms, viz., Systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg, which is the currently accepted dividing line based on epidemiological and intervention studies [16], with an age range of 20–59 years (group average age \pm S.D., 49.7 ± 9.5 years; sixty males; all non-smokers), participated in the study. The ninety participants were selected out of a larger sample of persons with hypertension visiting the out-patient department of a yoga and ayurveda hospital, located in northern India. The sample size was determined based on the number of participants who volunteered to take part in the trial. There was no attempt to determine the sample size based on previous effect sizes, which is a limitation of the study. Participants had to meet the following inclusion criteria: (i) diagnosed essential hypertension, not hypertension secondary to

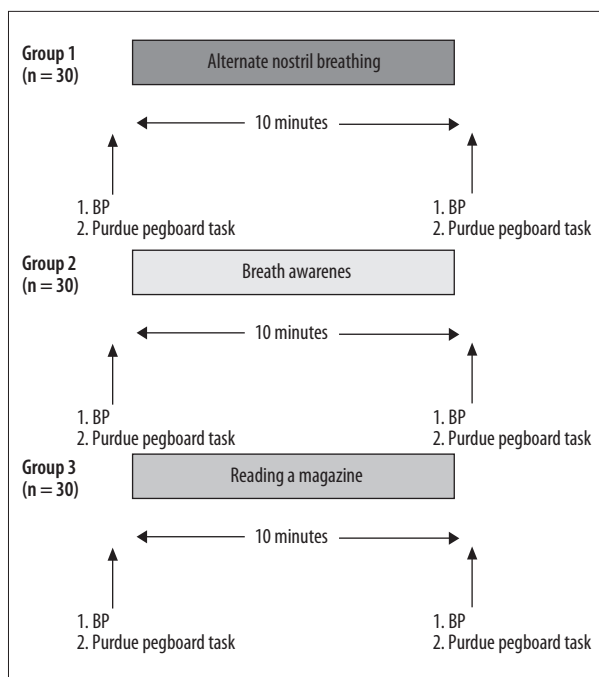


Figure 1. Design of the study.

any other condition, (ii) hypertension without complications, (iii) familiarity with the yoga practice (particularly ANYB) for a minimum of 6 months and regularity of practice (with practice for at least 30 minutes, 16 days in a month), (iv) blood pressure stabilized on medication (beta-blockers and/or diuretics in all cases), which was not altered during the trial, and (v) ability to perform the Purdue pegboard task. The participants were randomly assigned to three groups using a computer generated random table. All of them were right hand dominant based on the Edinburgh handedness inventory [17]. Signed informed consent forms of the participants were taken and the study was approved by the Institutions Ethics Committee.

Design

The participants were assessed before and after the intervention. The intervention was for ten minutes. During the ten minutes, one group practiced ANYB the second group practiced breath awareness, and the third group was asked to read a magazine with articles of neutral content. This has been shown schematically in Figure 1. The investigators, and assessors who were also data analyzers, were blinded to group allocation.

Assessments

Blood pressure

The blood pressure was measured using a standard mercury sphygmomanometer (ICCr=.824) auscultating over the right brachial artery, while the participants were seated. The diastolic

pressure was noted as the reading at which the Korotkoff sounds appeared muffled [18].

Purdue pegboard

The movement of arms, hands and fingers was measured using the Purdue pegboard (Lafayette instrument, Model 32020, USA; ICCr=.632). The pegboard has 25 holes on the left and right sides of the board. The participant had three tasks, viz., to place pegs in the holes on (i) the right side, (ii) the left side, and (iii) in both sides simultaneously. For tasks (i) and (ii) they used the respective hand (i.e., the left hand for the left side), and for task (iii) they used both hands simultaneously. The test was completed in 90 seconds, i.e., each task had to be completed within 30 seconds. Assessments were performed in a temperature regulated room, where the ambient temperature was maintained at $24 \pm 1^\circ\text{C}$. This is relevant as the temperature can influence the performance in the Purdue pegboard task [19].

Intervention

ANYB or anuloma-viloma pranayama

ANYB involves breathing through left and right nostrils alternately. In this practice the thumb and the ring finger of the right hand were used to manipulate or occlude the nostrils [20]. Throughout this practice the awareness is directed to the breath and breathing. The ANYB did not include breath retention. In 5 participants (taken as a representative sample) the average duration of inhalation was 3.4 seconds, the average duration of exhalation was 5.6 seconds, hence inhalation: exhalation was 1:1.6. None of the participants reported any adverse events resulting from the practice.

Breath awareness (control session)

During breath awareness, the participants maintained awareness of the breath without manipulation of the nostrils. The participants' attention was directed to the movement of air into and out of their nostrils. They also attempted to be aware of the air as it moved through their nasal passage. None of the participants reported any adverse events resulting from the practice.

Control intervention (read a magazine)

The third group was asked to read a magazine which had articles of neutral content, for the same duration, i.e., ten minutes.

Data analysis

The systolic BP, diastolic BP, and right hand, left hand, and both hands scores for the Purdue pegboard task were compared

Table 1. Purdue pegboard scores in participants with controlled hypertension.

Groups	Right hand		Left hand		Both hand	
	Pre	Post	Pre	Post	Pre	Post
Anuloma-viloma (n=30)	12.00±2.20	13.30***±2.02	11.13±1.61	11.37±2.22	8.97±1.56	9.40*±1.40
% change	10.83		2.15		4.79	
Breath awareness (n=30)	11.43±2.33	12.07± 2.05	10.87±2.01	11.10±1.81	8.53±1.81	8.70± 1.66
% change	5.59		2.11		1.99	
Reading a magazine (n=30)	11.57±2.43	12.37*±2.36	10.63±1.99	10.77±1.89	8.60±2.43	8.70±2.83
% change	6.91		1.31		1.16	

*p<0.05; ***p<0.001; RM ANOVA, with Bonferroni adjustment, pre compared with post session.

using a repeated measures analysis of variance (ANOVA), with one Between subjects factor [i.e., Groups, with three levels, ANYB group, breath awareness group and a group reading a yoga magazine], and one Within subjects factor [i.e., States, with two levels, before and after]. SPSS Version 14 was used for analyses.

Post-hoc analyses for multiple comparisons with Bonferroni adjustment was carried out to compare values recorded before and after ANYB, breath awareness, and the control session, separately.

Results

Purdue pegboard scores

(a) Repeated measures Analysis of Variance (ANOVA)

Right hand scores

The right hand scores for the Purdue pegboard task showed a significant difference between Pre and Post states, with (F=23.3, df=1, 29.0, p<0.001) but no significant difference between the three Groups.

Left hand scores

Left hand scores for the Purdue pegboard task showed no significant difference comparing Pre-Post and the three groups.

Both hand scores

Both hand scores of Purdue pegboard showed no significant difference comparing Pre-Post and the three groups.

(b) Post-hoc analysis

Multiple post-hoc comparisons were carried out with Bonferroni adjustment. The right hand scores for the Purdue pegboard were increased significantly following both ANYB (p<0.001, two-tailed by 10.8 percent) and reading a magazine (the control session) (p<0.05, two-tailed by 6.9 percent).

Both hand scores for the Purdue pegboard increased significantly following ANYB (p<0.05, two tailed).

The group mean values for the Purdue pegboard scores ±S.D. are given in Table 1.

Blood pressure

(a) Repeated measures Analysis of Variance (ANOVA)

There was a significant difference in the systolic blood pressure when (i) Pre and Post data were compared (F=24.38, df=1, 29.0, p<0.001) and (ii) between the three groups (i.e., ANYB, breath awareness, and a group reading a magazine, F=6.01, df=1, 29.0, p<0.05).

(b) Post-hoc analysis

Multiple post-hoc comparisons were carried out with Bonferroni adjustment. The systolic blood pressure significantly decreased immediately after the practice of ANYB (p<0.001, two-tailed) and breath awareness (the control session) (p<0.05, two-tailed) compared to pre. The diastolic blood pressure significantly decreased immediately after the practice of ANYB (p<0.05, two-tailed).

The group mean values ±S.D. are given in Table 2.

Table 2. Blood Pressure recordings in participants with controlled hypertension.

Groups	Systolic blood pressure		Diastolic blood pressure	
	Pre	Post	Pre	Post
Anuloma-viloma (n=31)	133.67±14.26	128.00***±10.64	85.67±8.58	84.33*±7.28
% change		-4.24		-1.56
Breath awareness (n=31)	130.67±16.39	127.20*±13.72	84.33±10.73	83.73±9.26
% change		-2.65		-0.71
Reading a magazine (n=31)	140.83±14.22	139.53±18.65	81.20±9.42	81.33±9.37
% change		-0.92		0.16

*p<0.05; ***p<0.001; RM ANOVA, with Bonferroni adjustment, pre compared with post session.

Discussion

Participants with essential hypertension showed a significant reduction in systolic blood pressure after ANYB and after breath awareness, while diastolic blood pressure reduced after ANYB alone. Purdue pegboard scores for both hands were increased after ANYB and dominant (right) hand scores were increased after ANYB and after no intervention (reading a magazine).

The mechanism by which ANYB may be reducing the blood pressure is complex. The change is possibly related to better parasympathetic control over the cardio-vascular system. While systolic blood pressure is usually determined by cardiac output, diastolic blood pressure is more closely associated with inflation of the lung and a decrease in peripheral vascular resistance [21,22]. The connection between breathing through a particular nostril and altered autonomic activity is less clear. Autonomic and central controls regulate nasal airflow [23]. Nasal airflow is also influenced by the nasal vasculature. Sympathetic nerves which regulate the nasal vasculature are regulated by the hypothalamus and vasomotor centers in the brainstem [24]. Sympathetic activation through hypothalamic nuclei is believed to be closely related to airflow through the right nostril. Hence breathing through alternate nostrils is believed to bring about a balance between sympathetic and parasympathetic nervous systems, and hence reduce the blood pressure.

The decrease in systolic blood pressure following breath awareness also be due to complex factors. Clinical unpublished data showed that patients often respond differently to specific yoga practices when compared with normal volunteers. Certain techniques which do not bring about a change in normal volunteers do cause changes in patients. It is believed that this is the reason why the present group of people with hypertension showed a decrease in blood pressure with breath

awareness, whereas in earlier studies the volunteers all had normal blood pressure and hence showed no change. There were no other major differences. The instructions given for breath awareness were the same as earlier studies and participants of both groups had comparable exposure to mindful breathing practices.

An elevated BP has been associated with poor cognitive performance in certain tasks requiring attention and co-ordination [25]. This study cites a report in which a 6-month period of anti-hypertensive therapy was associated with a significant reduction in group average systolic blood pressure and a significant increase in mean Mini-Mental State Examination scores. Multiple linear regression showed that cognitive decline was independently and inversely correlated with systolic BP reduction.

The present results suggest that ANYB improved the performance in the Purdue pegboard task which required better co-ordination, dexterity and attention. Normally attention is associated with increased sympathetic nervous system activity [11] but in this case the two were not associated. It is possible that reading a magazine helped the 'control' group to focus their attention better. The magazines given to the group to read were assumed to be neutral in content as they covered topics such as interior decoration and cookery which were included in the yoga magazine. All the same, the participants may have got involved in the content of the articles and this may have helped them to be focused.

Hence after yoga practice, particularly ANYB, the neural pathways regulating the autonomic nervous system and the pathways involved in focusing attention appear to be separate and distinct. Apart from the ability to focus attention, anxiety (and hence sympathetic arousal) have been shown to reduce performance in tests requiring attention [26]. The Purdue pegboard

task requires single hand and bimanual dexterity, ability to continue the task without fatigue and eye-hand co-ordination, all of which require attention [2].

However earlier studies assessed attention following ANYB using cancellation tests. Hence on a small sub sample of 15 individuals with essential hypertension the blood pressure was recorded along with participants performing the letter cancellation task (which was assessed in earlier studies). This helped to reduce the difficulty in understanding the goals which had arisen as a new task (i.e., the Purdue pegboard task) which was not used in earlier studies was introduced. The results were as follows. Following ANYB the 15 participants showed a non – significant decrease in blood pressure ($p=0.28$, α at.05, t test for paired data). Along with this, they also showed non – significant increases in net scores in the letter cancellation task ($p=0.08$, α at.05, t test for paired data) after ANYB. These results suggest a trend of improved performance in the cancellation task in people with hypertension with no increase in blood pressure. The lack of significance may be due to the small sample size.

In the present study the participants had essential hypertension. This suggests that even if these patients perform tasks

normally associated with sympathetic activation, the practice of ANYB could improve their performance without increasing the blood pressure. These results are in agreement with those an earlier randomized control trial which showed that yoga respiratory training improves respiratory functions and shifts autonomic balance (based on heart rate variability) towards reduced cardiac sympathetic activity [27].

Conclusions

The present study showed that the practice of alternate yoga nostril breathing (ANYB) and breath awareness (BAW) reduced the systolic and diastolic BP (ANYB) and systolic BP (BAW) when people with hypertension performed the Purdue pegboard task (with better score after ANYB). Since the task requires dexterity and co-ordination, it also requires focusing. Focusing is known to be associated with sympathetic activation. Hence ANYB reduces BP but improves performance in a skilled motor task in people with hypertension. These results suggest a possible role for ANYB in helping people with hypertension to perform focused tasks without sympathetic activation (based on an increased BP).

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