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Original Article

Effectiveness of Slow Breathing on Blood Pressure and Quality of Life in Patients with Hypertension: A Randomized Trial

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ABSTRACT

Background: Hypertension constitutes a significant cardiovascular burden globally. Non-pharmacological interventions are highly sought either as an adjunct or primary means of managing hypertension. Slow breathing (SB) is one of such approach which gains attention in recent times due to its multiple physiological benefits in lowering blood pressure (BP). However, there is a gap in literature testing the ability of SB training on quality of life (QOL) of hypertensive (HT) patients.

Aim of the Study: This study aims to find out the effectiveness of SB on reduction of BP and improvement in the health-related QOL in HT patients.

Materials and Methods: It was a randomized, open, and parallel-group trial design carried out at the Outpatient Department of Medicine in Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India. The study consists of 60 HT patients assigned equally to either study or control group. The study group was trained with SB training for 4 weeks, whereas no specific treatment was given for controls.

Results: The mean drop in systolic BP (SBP) for the study group was 14.24 ± 3.30 mmHg, whereas the mean drop was only 5.28 ± 2.26 mmHg for controls. The mean drop in diastolic BP (DBP) was 6.20 ± 2.69 mmHg for the study group, whereas it was only 3.12 ± 2.05 mmHg for controls. There was significantly higher drop in systolic as well as DBP in the study group. Likewise, the World Health Organization QOL-BREF (WHOQOL-BREF) was improved to 10.79 ± 5.47 in the 0–100 scale for the study group, whereas the mean improvement in the WHOQOL-BREF for control was 5.95 ± 0.01 in the 0–100 point scale.

Conclusions: It was concluded that 4 weeks of SB training were effective in reducing BP and improving QOL in patients with HT.

Key words: Breathing training, High blood pressure, Hypertension, Non-pharmacological measures, Quality of life, Slow breathing

INTRODUCTION

Hypertension (HT) is an important cause of premature death globally.[1] In India, HT accounts for substantial mortality and morbidity and ranks one of the tops in the world.[2] The Government of India in association with Registrar General of India had carried out the prevalence of risk factors of cardiovascular diseases including HT in the District Level Household Survey-4 and it found that the prevalence of HT in India is 25.3%.[3] It further states that there is convergence of rural-urban and rich-poor difference in its prevalence.[3,4] Non-pharmacological therapy plays a key role either as a first-line management or adjuncts to drug therapy in the management of various stages of HT.[5,6] One of such approach which gains popularity in the recent times is practice of slow breathing (SB). As the name implies, SB involves slowing of respiratory rate (RR) to 10 or less with high tidal volume. There are multiple physiological benefits of SB in controlling blood pressure (BP), which includes enhancement of slowly adapting pulmonary stretch receptors,[7] improvement in the baroreceptor sensitivity,[7-11]

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and reduced sympathetic[11,12] and chemoreceptor activity.[13] Recent evidence support that it has favorable changes in blood gases, particularly lowering of partial pressure of carbon dioxide to produce long-term changes in BP.[13,14] HT is a chronic disorder and, therefore, apart from the regular physiological evaluation such as magnitude of BP and associated comorbidities, the self-assessment of quality of health is vital in better estimating the health condition. It is well reported that the self-evaluation of health status by the patient superiorly predicts the disease severity and death than most of the available objective measures.[15] In majority of the previous studies, the effectiveness of SB with respect to various physiological measures has only attempted, the vital parameter of health-related quality of life (HRQOL) is neglected. Further, SB is performed by interactive breathing device (IBD) in most of the previous work.[16-18] The IBD is limited in its availability and it is expensive. To overcome those gaps, in the present work, HRQOL is used as one of the primary outcome measures along with BP monitoring. The SB is trained by recorded auditory command in the present investigation. The World Health Organization QOL-BREF (WHOQOL-BREF) is a tool of selection to estimate HRQOL. The rationale for choosing the WHOQOL-BREF is that it specifically evaluates QOL which is the missing element in most of the assessment scales. Further, the WHOQOL-BREF is designed in such a way that it is beyond cultural variation and it best suits to international community. Therefore, the aim of the present investigation is to find out the effectiveness of 4 weeks of SB training on BP and QOL in patients with HT by listing the following research hypothesis. Null hypothesis (H_0): 4 weeks of SB are not effective in reducing BP and improving QOL in HT. Alternating hypothesis (H_1): 4 weeks of SB are effective in reducing BP and improving QOL in HT.

MATERIALS AND METHODS

Trial Design

This was an open, parallel-group, and randomized clinical trial.

Participants

Final stage, 60 HT patients were selected and randomly assigned to either experimental or the control group. Allocation to the study group was done by blocked randomization method. The block size was 4 and hence through six ways allocation was performed and it was carried out by a third person, a physiotherapist to maintain allocation concealment.

The study was ethically approved by the Institutional Human Ethics Committee of RMMC and H, Annamalai University, Chidambaram, Tamil Nadu.

Sample Size Estimation

Sample size was estimated with the level of significance of 5%, that is, $z\,\alpha/2 = 1.96$, power of 80%, that is, $z\beta = 0.84$, standard deviation of 10 mmHg and clinically significant improvement of 10 mmHg. Therefore, the sample size was 30 in each group.

Selection Criteria

Age between 30 and 60 years, both genders were included in the study. Joint National Committee-7 (JNC-7) of pre and Stage I HT was only chosen as they were the most suitable for SB, medication with calcium channel blockers with same drug and constant dosage for at least 2 weeks before the onset of the study were only chosen better to avoid the drug influence of autonomic nervous system; patients without history of cardiovascular diseases, transient ischemic attack, and stroke were not selected; patients doing regular exercise and involved in other forms of treatment were excluded from the study.

Settings

This study was conducted at the Outpatient Department of Medicine, Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India.

Allocation Process

The patients were allotted to the corresponding groups using blocked randomization method [Figure 1].

Intervention

The study purpose and procedure were explained. Patients were instructed to relax in a chair for 15 min before the commencement of pre-evaluation. Thereafter, BP evaluation was carried out and the response of self-administered HRQOL questionnaire was obtained. The experimental group was instructed about SB and a prior practice was given.

SB

It involves 4 s of inspiration and 6 s of expiration.[11] The recorded auditory command was used as a cue to provide breathing training.[19] The constant, repeated command of inhalation and exhalation was used as means of SB. Therefore, breathing rate was reduced to 6 breaths/min and it was performed for ½ h in succession. The practice was carried out for 5 days in a week for 4 consecutive weeks.[16,19] Patients were told to avoid breath holding during the training and if they were not able to follow the breathing sequence during the course of training, they were instructed to do normal breathing until they were returning back to the sequence of SB. It was practiced under the supervision of physiotherapists for 2 days in a week and for remaining 3 days, practice was carried out in patients home. Home complaints were monitored and evaluated by the self-adherence rating scale.[20] Those who had 7 or more in the

numerical rating scale of 10 were only taken for analysis.

For the control group, SB was not given but was instructed to take regular course of antihypertensive (HT) pills prescribed by the physician. They were followed up once in a week for the total period of 4 weeks to ascertain that there was no change in the current treatment regimen.

Outcomes

Primary

(i) Systolic BP (SBP) and diastolic BP (DBP)
BP was recorded in an arm supported table with a backrest chair in a sitting position. Feet were completely placed in a floor. Monitoring was done for 3 times with the interval of each of 5 min. The average of the last two measures was taken as final BP reading. The measurement was carried out by the standard mercury sphygmomanometer.

(ii) WHOQOL-BREF[21]
It consists of 26 questions. It evaluates QOL with respect to four domains, namely, physical health, psychological, social relationship, and environmental. The raw scores in each domain were transformed into the scores of 0–100 scale and the overall score was calculated by finding the mean of all the four domains. It is a 5-point Likert's scale with 5 denotes maximum and 1 denotes least score. The score of

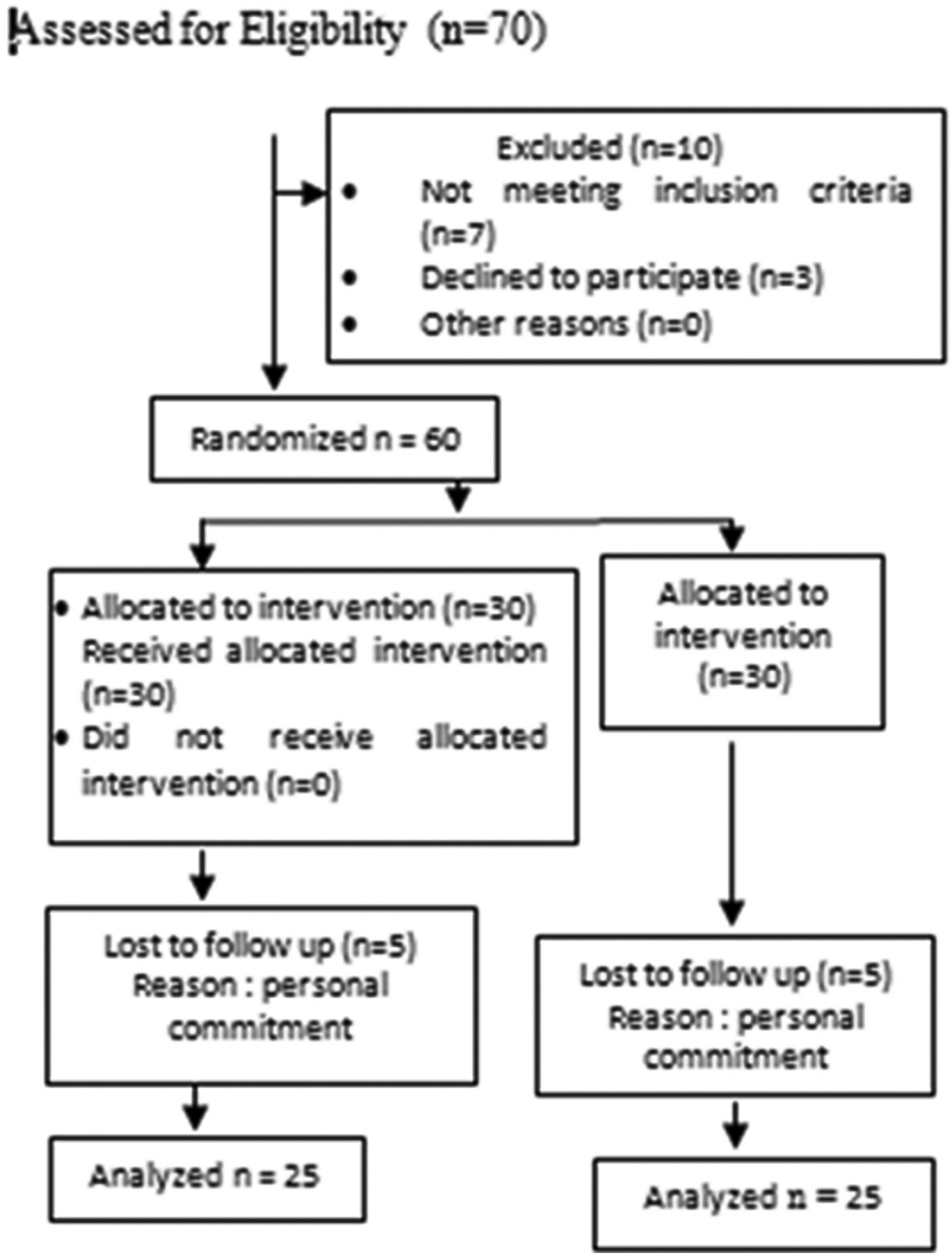

Figure 1: Patient allocation flow diagram

question number 3, 4, and 26 was reversed as they were negatively phrased items. As the domain scores were scaled in positive direction, higher scores represent higher QOL and vice versa.

Secondary

(i) Pulse rate (PR)
PR was evaluated by handheld pulse oximetry.[22] It was recorded thrice with an interval of 5 min each and the average of the last two measures was considered as final value.

(ii) RR
It was evaluated by EMMA Capnometer.[23] The patients were told to breath normally for few breaths in a handheld Capnometer. The extrapolated RR was displaced in the screen. It was recorded thrice with an interval of each of 5 min and an average of the last two measures was taken as final value.

Statistical Analysis

Basic characteristic findings were tested for homogeneity using independent sample "*t*" test. Within-group before and after intervention, comparison was carried out by the paired sample "*t*" test. The mean difference of pre- and post-values of the outcomes was compared between groups using independent sample "*t*" test. The parametric test was selected because the distribution of the data was normal and the unit of measurement was in interval scale. The entire statistical analysis was carried out by the Statistical Package for the Social Sciences (SPSS-21).

RESULTS

The anthropometric measures such as age, gender, and body mass index were homogenous between groups at the baseline. Likewise, the outcomes such as SBP, DBP, PR, RR, and WHOQOL-BREF were homogenous between groups at the start of the study [Table 1].

The post-values of the outcomes are shown in Figure 2. It is inferred that post-values of vital parameters such as BP, PR, and RR were comparatively lower in the study group.

It is inferred from Table 2 that there was a significant reduction in BP, PR, and RR in the study group following treatment. In controls, significant reduction was observed in SBP, PR, and RR following the study period, but reduction in DBP was statistically insignificant. The WHOQOL-BREF was significantly improved following treatment in the study group. Likewise, it has improved significantly after the study period in controls.

Between-group comparisons of outcome [Table 3] show that there was significantly higher improvement in all the outcomes (SBP, DBP, PR, RR, and WHO-BREF) in the study group when compared to controls.

The individual domain scores of all the four aspects of the WHOQOL-BREF were shown comparatively higher improvement in the study group [Table 4].

DISCUSSION

In the current study, SBP was reduced to 14.24 ± 3.30 mmHg for the study group which is well above the clinically significant improvement. The present work methodology is similar to the study done by Swarnalatha,[19] who also demonstrated a significant

Table 1: Basic characteristic of the study patients

Parameters	Study		Control		
	M	SD	M	SD	"*P*"
Age (years)	44.72	8.04	43.48	8.81	0.606
Gender (male/female) %	60	40	56	44	0.622
Body mass index	24.89	2.67	25.60	2.40	0.322
Systolic blood pressure (mmHg)	145.64	8.05	144.0	8.59	0.50
Diastolic blood pressure (mmHg)	94.96	8.19	91.96	4.12	0.06
Pulse rate (beats/min)	84.8	7.39	86.36	8.88	0.50
Respiratory rate (breaths/min)	17.08	2.41	16.36	1.84	0.24
WHOQOL-BREF	56.56	11.81	57.05	9.69	0.87

M: Mean, SD: Standard Deviation, *P:* Probability value, WHOQOL-BREF: World Health Organization quality of life-BREF

Table 2: Within-group comparison of outcomes following treatment

Outcomes	Study				Control			
	M	SD	"*t*"	"*P*"	M	SD	"*t*"	"*P*"
Systolic blood pressure	−14.24	3.30	21.52	0.001	−5.28	2.26	7.47	0.001
Diastolic blood pressure	−6.20	2.69	11.51	0.001	−3.12	2.08	1.10	0.278
Pulse rate	−3.52	3.57	4.92	0.001	−0.40	1.80	3.36	0.003
Respiratory rate	−3.08	1.03	14.84	0.001	−0.80	1.19	9.86	0.001
WHO-BREF	10.79	5.47	1.66	0.001	3.07	3.47	4.42	0.001

M: Mean, SD: Standard Deviation, *P:* Probability value, *t* :Test statistics, WHO-BREF: World Health Organization-BREF

Table 3: Difference in the outcome between groups following treatment

Outcomes	MD	SD. error	"*t*"	"*P*"
Systolic blood pressure	−8.96	0.801	11.17	0.001
Diastolic blood pressure	−3.08	0.68	4.52	0.001
Pulse rate	−3.12	0.80	3.89	0.001
Respiratory rate	−2.28	0.31	7.22	0.001
WHOQOL-BREF	7.72	1.29	5.95	0.001

MD: Mean difference, SD. error: Standard error, *P:* Probability value, *t*: Test statistics, WHOQOL-BREF: World Health Organization quality of life-BREF

reduction in BP following 4 weeks of training, but mean arterial pressure was used as outcome rather than SBP and DBP. Elliot *et al*.[18] had also demonstrated a significant reduction in systolic and DBP following 180 min of training over 8 weeks in SB. The magnitude of improvement was also similar to the present work, the mean drop in SBP was 15 mmHg and DBP was 5 mmHg. In the present work, on an average, there were 8.96 ± 0.801 mmHg of higher SBP reduction which was observed in the study group when compared to controls. The magnitude of improvement on an average was 3.08 ± 0.68 mmHg for DBP in the study group than in controls. Therefore, there was considerable degree of improvement in BP which was observed in the study group. There was a significant drop in PR and RR which were noted in the study group following training. However, the mean drop was 3.52 ± 3.57 beats/min and 3.08 ± 1.03 breaths/min for PR and rater, respectively. Even though these two parameters were reduced following training, drop was less in magnitude. Hence, apart from the reduction in sympathetic nervous system activity, there could be other factors influencing BP drop following training. It was suggested that SB training causes positive influence of long-term control of BP by altering blood gases, particularly lowering the carbon dioxide which ultimately increases renal excretion of sodium and drop in BP.[14,16] Cardiac output and total peripheral resistance are the important factors influencing BP. As there was not much change in PR, SBs ability in lowering peripheral resistance could be the factor in BP reduction. Activation of slowly adapting pulmonary stretch receptors by the practice of SB positively influences peripheral resistance by causing vasodilatation of the peripheral arteries.[14]

Table 4: Comparison of individual domain scores of the WHO-BREF between groups

Domain	M D	SD. error	"*t*"	"*P*"
Domain-I (psychological)	9.88	2.10	4.70	0.001
Domain-II (physical)	9.24	2.39	3.86	0.001
Domain-III (social relationship)	4.20	2.29	1.82	0.07
Domain IV (environmental)	7.28	1.50	4.83	0.001

MD: Mean difference, SD. error: Standard error, *P*: Probability value, *t*: Test statistics, WHO-BREF: World Health Organization-BREF

QOL was significantly improved following SB in the study group. The degree of improvement was 10.79 ± 5.47 in the 0–100 scale of the WHOQOL-BRIEF. Therefore approximately 11% improvement was noted in the current health related QOL in the study group following training and which was found to be a improvement. Further, the improvement in QOL was significantly higher in the study group than in controls. On an average, there were 7.72 ± 1.29% higher improvements in QOL for the study groups when compared to controls. The influence of SB on QOL is not yet studied and the positive result of the current findings could add a great value to the present work. The WHOQOL-BREF has four domains, namely, physical, psychological, social relationship, and environmental. On analyzing each domain, the degree of improvement was much greater in physical and psychological domains in the study group. There was a significantly higher improvement in all the domains following training in the study group when compared to controls. Subjective evaluation of well-being is equally important to physical measures in evaluating the treatments. Hence, SB can be an effective adjunct in managing hypertension. In the present work, SB was trained by recorded auditory command, which is a simple means of doing SB. In the majority of previous work, SB was trained by special device which is costly and limited in availability.[14,16,17]

Limitation and Recommendations

The outcomes such as arterial carbon dioxide, baroreceptor sensitivity, renal measures, and heart rate variability can be included in the future endeavor to analyze in depth the influence of SB on these measures. The estimation of frequency and duration of SB training needs to be

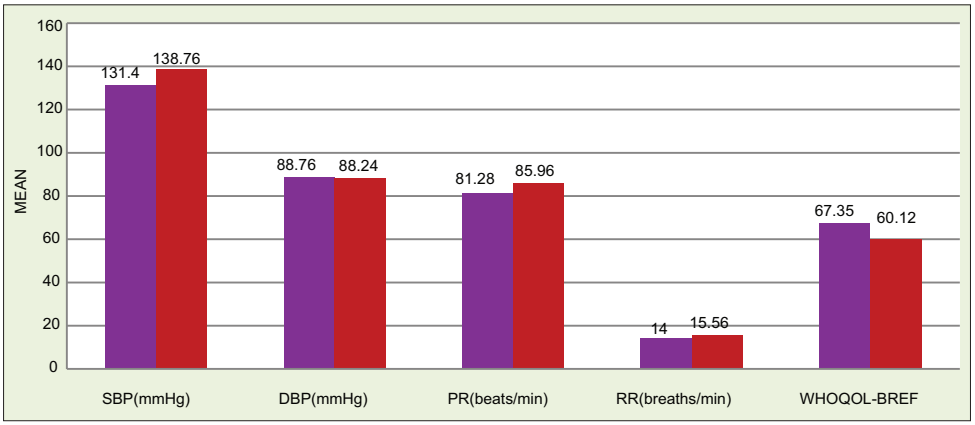

Figure 2: Post-outcomes

evaluated extensively to find out the optimal threshold of the SB training.

CONCLUSIONS

Four weeks of SB significantly improves BP and health-related QOL in patients with hypertension. It is suggested that SB is an effective adjunct in managing hypertension and could be incorporated with regular course of medication for the effective BP control.

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