



Device-guided breathing exercises in the treatment of hypertension – perceptions and effects

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Summary

Background: Behavioural and non-pharmacological treatments of hypertension suggest that relaxation and stress management can lower blood pressure (BP). There have been several studies showing that breathing exercises using various behavioural approaches, such as yoga, relaxation, biofeedback and transcendental meditation benefit hypertensive patients by decreasing their BP.

Methods: A randomized controlled pilot study was conducted over a period of 16 weeks, including 31 patients in the intervention-group using Resperate. A control group of 22 patients only listened to music (CD) and used no other therapeutic device. The exercises were accomplished over 15 minutes, three times a week in both groups. Patients ($n = 18$) from both groups were interviewed about their perceptions of the treatment.

Results: After 16 weeks, the systolic blood pressure decreased -3.9 mmHg ($p = 0.105$) in the Resperate group and -16.8 mmHg ($p = 0.000$) in the CD group. The diastolic blood pressure decreased in the Resperate group -1.5 mmHg ($p = 0.000$) and in the CD group -4.1 mmHg ($p = 0.000$). The breathing frequency was lowered in the Resperate group -2.4 /min ($p = 0.000$) and in the CD group -1.2 /min ($p = 0.232$) after 16 weeks. There were no statistically significant differences between the groups. Patients generally were satisfied with the use of devices

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and seemed to perceive the treatment as a chance to influence their own health. *Conclusions:* The use of device guided breathing exercises (Resperate) indicated an antihypertensive effect but only listening to relaxing music also decreased blood pressure.

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Introduction

Behavioural and non-pharmacological treatments of hypertension suggest that relaxation and stress management can lower blood pressure (BP). There have been several studies showing that breathing exercises using various behavioural approaches, such as yoga, relaxation, biofeedback and transcendental meditation benefit hypertensive patients by decreasing their BP [1–6]. A few clinical trials have shown that listening to music can lower BP [7,8]. It is beneficial to patients when pharmacological and non-pharmacological treatment complement each other since treating hypertension with drugs involves possible side effects of treatment. Non-pharmacological treatment can help to reduce the side effects and expenses of antihypertensive drugs [9].

Recent research has demonstrated the antihypertensive effect of slow breathing exercises-DGBE (Device-Guided-Breathing-Exercises) guided interactively by a device [10–15].

The method has been found to be simple to use, without side effects. The result is based on the fact that slow and regular breathing has an effect on autonomic imbalance, which is thought to be an important factor in the development of hypertension [16]. However follow-up studies have included few patients. Parati and Carreta [17] suggest possible areas of improvement for studies of DGBE such as measuring breathing frequency (BF) in the control group during the entire study period and collection of information on patient adherence to breathing exercises. We set out to scrutinize these questions in a pilot study as well as to examine the antihypertensive effect and patient perceptions of managing the device, Resperate. We included a control group which listened to music (CD) without use of any therapeutic device.

Materials and methods

Subjects

The inclusion criteria were: diagnosis of hypertension with or without pharmacological treatment, ability to understand Swedish and age 35–85 years.

Exclusion criteria were more than two risk factors for hypertension, pregnancy, blindness, deafness, a major psychiatric diagnosis or other serious somatic disease. All the patients were recruited from one primary health care centre in the southern part of Sweden.

Methods

Patients who fulfilled the study criteria were invited to participate. After enrolment and two weeks of run-in, patients were randomized into the Resperate group ($n = 32$) or the CD group ($n = 22$). For randomization, fifty cards marked CD and fifty marked Resperate were placed in envelopes, which were sealed, shuffled like a deck of cards and then numbered from 1 to 100. This was done by another department before the investigation started. Patients were randomized according to the content in the envelope taken out in order from 1 and upwards. Patients in the Resperate group were informed that treatment would consist of listening to music produced by the Resperate device (InterCure Ltd, Lod, Israel), for 15 min, 3 times a week during 16 weeks. The device includes a belt type respiration sensor connected to a computerized box that generates musical patterns through earphones. The device guides the user to slow breathing with a relatively prolonged expiration by monitoring breathing patterns, synthesizing musical patterns with “inspiratory” and “expiratory” sounds, and synchronizing inhaling and exhaling with musical sounds. Patients were instructed how to use the treatment device during the first visit. The target breathing frequency (BF) at the end of the exercise was less than 10 breaths/min. Patients in the CD group were provided with a CD with relaxing music (CD Spa & Wellness (Rest and Relaxation) by Fønix music) on a CD portable player – CDP 1410 AS 45.

Treatment time (time for listening to music and time for follow-up) was the same for both groups. All patients visited the health care centre five times (once a month) for measurement of blood pressure, BF, and heart rate during the study and all measurements were standardized. The nurse, at the first appointment, took notes on the history of hypertension or other diseases, medication,

leisure-time exercise and smoking habits. Blood samples were drawn in the fasting state for determination of blood glucose, serum triglycerides, and serum total cholesterol concentrations. Body mass index (BMI) was calculated. Changes in medical treatment and any new medication were registered.

Blood pressure, heart rate and BF were measured with the patient in a sitting position. After four weeks of treatment, a sample of eighteen patients was interviewed about management and perception concerning the use of the Resperate or the CD player. The patients were selected from a convenient sample from both groups. Twelve patients (8 women, 4 men) had used the Resperate and six patients (5 women, 1 man) had used the CD player. All of these patients agreed to be interviewed from 15 to 30 min. The aim of the interviews was explained and consisted of open-and closed-ended questions. The interviewer transcribed all the responses verbatim. Data were subjected to content analysis [18]. The author searched for similarities and differences in the written answers from the interviews. In the next step the author identified categories that appeared meaningful. The first author made the analysis and the co-authors (IE, KIK) also read the interviews and, after a few adjustments, all agreed on the formulated categories.

Statistical methods

Statistical analyses were conducted with the statistical package SPSS 14. for Windows. Wilcoxon's

signed ranks test was used to estimate the differences between the paired observations of blood pressure and BF. Between groups comparisons of systolic (SBP) and diastolic blood pressure (DBP) were made using Wald–Wolfowitz runs test. This is a non-parametric test that checks the randomness hypothesis of a data sequence [19]. A p -value < 0.05 was considered significant.

The study was approved by The Ethics Committee of University of Gothenburg, Sweden, study code D 107-5 and carried out in accordance with the 1975 Declaration of Helsinki. All participants were informed about the purpose of the study and signed a consent form.

Results

Fifty-three patients with hypertension, $\geq 140/90$ mmHg, 14 males and 39 females, with or without pharmacological treatment participated in the study. One patient dropped out from the Resperate group after randomization. The baseline characteristics of the patients are listed in Table 1.

Systolic blood pressure

The SBP in the Resperate and the CD group was observed after 4, 8, 12 and 16 weeks, Table 2. After 16 weeks, the decrease in SBP in the Resperate group was -3.9 mmHg ($p = 0.105$) and in the CD group -16.8 mmHg ($p = 0.000$) compared to baseline.

Table 1 Demographic and clinical characteristics of the study subjects at baseline^a

	Resperate group ($n = 31$)	CD group ($n = 22$)
Age (year)	70.42 \pm 8.7	66.50 \pm 8.3
Gender (M/F)	10/21	4/18
Years since hypertension diagnosis	10.00 \pm 10.7	8.45 \pm 9.2
Patients on no drug treatment	7	5
Patients on one antihypertensive drug	7	5
Patients ≥ 2 antihypertensive drugs	17	12
SBP (mmHg)	146.61 \pm 15.00	151.82 \pm 15.70
DBP (mmHg)	80.97 \pm 10.60	80.50 \pm 9.50
Heart rate (beats/min)	65.4 \pm 7.4	67.5 \pm 7.1
BF (inhalations/min)	13.66 \pm 2.80	13.43 \pm 3.20
Height (cm)	169.1 \pm 8.3	165.9 \pm 8.3
Weight (kg)	76.8 \pm 15.5	73.5 \pm 15.8
BMI (kg/m ²)	26.7 \pm 4.1	26.4 \pm 4.5
fS-chol (mmol/L)	5.9 \pm 1.3	5.5 \pm 0.7
fS-glucose (mmol/L)	5.8 \pm 1.0	5.9 \pm 1.0
Physical activity (times/week)	4.3 \pm 2.3	4.8 \pm 1.8
Smokers	5	0

^a Data are presented as mean \pm s.d. except gender, drug treatment and number of smokers which is n (number).

Table 2 Changes in systolic blood pressure (SBP) in mmHg in the Resperate and the CD groups after 16 weeks of treatment

	Resperate group (n = 31)	P-value Resperate group ^a	CD group (n = 22)	P-value CD group ^a	P-value between groups
SBP at inclusion	146.61 ± 15.0		151.82 ± 15.7		ns
SBP after 4 weeks of treatment	140.65 ± 13.7	0.027	141.32 ± 16.3	0.002	ns
SBP after 8 weeks of treatment	143.29 ± 13.8	0.180	139.86 ± 14.4	0.004	ns
SBP after 12 weeks of treatment	139.23 ± 14.7	0.008	136.18 ± 12.7	0.001	ns
SBP after 16 weeks of treatment	142.73 ± 13.9	0.105	135.05 ± 10.6	0.000	ns

^a P value relative to inclusion.

Table 3 Changes in diastolic blood pressure (DBP) in mmHg in the Resperate and the CD groups after 16 weeks of treatment

	Resperate group (n = 31)	P-value Resperate group ^a	CD group (n = 22)	P-value CD group ^a	P-value between groups
DBP at inclusion	80.97 ± 10.6		82.77 ± 9.8		ns
DBP after 4 weeks of treatment	78.39 ± 10.5	0.090	80.50 ± 9.5	0.220	ns
DBP after 8 weeks of treatment	79.10 ± 10.2	0.100	79.91 ± 10.5	0.282	ns
DBP after 12 weeks of treatment	77.61 ± 10.1	0.076	78.82 ± 8.7	0.095	ns
DBP after 16 weeks of treatment	79.50 ± 9.8	0.000	78.70 ± 7.7	0.000	ns

^a P value relative to inclusion.

Diastolic blood pressure

The DBP decrease is shown in Table 3. After 16 weeks the decrease in DBP in the Resperate group was -1.5 mmHg ($p = 0.000$) and in the CD group -4.1 mmHg ($p = 0.000$).

Breathing frequency

BF was lowered during the treatment in both groups as presented in Table 4. After 16 weeks of treatment the decrease was more marked in the Resperate group; -2.4 /min ($p = 0.000$) compared to -1.2 ($p = 0.232$) in the CD group.

Differences between the groups

After 16 weeks of treatment the Wald–Wolfowitz runs test did not show any significant differences

between the groups regarding decrease in SBP, DBP or BF.

Findings from the interviews

The following nine categories were formulated which describe the patients' management and perceptions of Resperate and CD player: relaxation, some small activity, time for treatment, perception of treatment, effects of treatment, physical and spiritual well-being, difficulties during the treatment, adherence and improvement of devices. The categories are illustrated below with quotes and presented by interview number and whether the patients used Resperate or CD player.

Relaxation

Most of the patients in both groups were trying to relax and coordinate their breathing to the rhythm

Table 4 Changes in breathing frequency (BF) changes in the Resperate and CD groups after 16 weeks of treatment

	Resperate group (n = 31)	P-value Resperate group ^a	CD group (n = 22)	P-value CD group ^a	P-value between groups
BF at inclusion	13.66 ± 2.8		13.43 ± 3.2		
BF after 4 weeks of treatment	11.57 ± 3.01	0.000	12.14 ± 2.8	0.054	ns
BF after 8 weeks of treatment	11.32 ± 2.8	0.000	11.24 ± 1.9	0.012	ns
BF after 12 weeks of treatment	11.13 ± 3.6	0.001	12.24 ± 3.1	0.096	ns
BF after 16 weeks of treatment	11.23 ± 3.3	0.000	12.25 ± 3.4	0.232	ns

^a P value relative to inclusion.

of the sounds coming from the Resperate or the CD player. The relaxation could include attempts to achieve a reduction in muscular tension and to regulate patterns of breathing as described below.

“I usually sit on a chair, while I am completely alone. It feels good, since no one can disturb me... I close my eyes, relax and try to breath by following the rhythm of the music...” (ID 3; R)

Some small activity

Four patients in the CD group mentioned that they were using the CD player while doing some other activity and two of them were using the CD player at work. Patients in the Resperate group did not report other activities during the treatment, probably because the treatment required more concentration on the patterns of breathing.

“During the day, I use it while I am busy doing something else, for example while I stand and iron or wash dishes or do something else.” (ID 11; C)

Make time for treatment

Most of the patients in both groups preferred to use the Resperate or CD player during the evenings or afternoons. Only two of them preferred mornings. One woman found a personal way to use the Resperate.

“It works best for me to use it while I am at home and alone. I chose three different time intervals that suit me best, to use the device: one day when I am very busy, one day when I am free and one day during the weekends.” (ID 3; R)

Perception of treatment

All of the patients, except one, said that their time spent using either the Resperate or CD player, was positive and gave a sensation of calm and relaxation and therefore no differences were found between these patients.

“It feels so good and as a matter of fact it is calming. I did not believe in it previously. It feels comfortable in a certain way.”(ID 6; R)

Effects of treatment

Concerning the question about the effect of the Resperate or CD player, only three patients mentioned high blood pressure:

“I hope that the device gives results and is capable of lowering my blood pressure.” (ID 6; R)

Physical and spiritual well-being

The patients described the use of the Resperate or the CD player as being very positive. The most common perception was that of a general feeling of relaxation, balance and harmony. They expressed a feeling of physical and spiritual well-being.

“I think that the device is good, since it allows me to relax and feel well and more in harmony. In the long run, I think that it makes me feel calm since I am usually worried for my health.” (ID 5;R)

Difficulties during the treatment

When asked about any difficulties regarding the use of the Resperate or CD player, one patient who used the CD player, mentioned that he had purchased new earphones. Two patients who used the Resperate, found difficulties in breathing and also in following the rhythm, at the beginning of treatment.

“The first time it was difficult to follow inhaling and exhaling, I couldn’t keep the rhythm. It felt as if I was forced to hold my breath too long, and felt under stress. Now I can follow the rhythm well, by sometimes compensating with a “deep breath”, when I feel strained.” (ID 3; R)

Adherence

We found that all of the patients had followed the instructions thoroughly and used the device at least three times per week, at 15-minute sessions. Some of them had used them even two times per day. When asked about how it felt to use the Resperate or CD player, all eighteen patients answered “good”. The patients were also satisfied with the use of devices due to the fact that it gave them the chance to influence their own health in a positive manner.

“It is good and relaxing. I am satisfied. I had a positive attitude from the beginning and I think that it is good to be able to do something about my own health, myself.” (ID 3; R)

Improvement of devices

None of the patients who used the Resperate had any suggestions on how to improve it. Some of the patients who used the CD player mentioned

that they would like to have more than one CD, and some found that the earphones were too small.

Discussion

This study indicates that breathing exercises guided by Resperate for 15 min three times a week are effective in lowering BP. Overall our data also suggest that listening to relaxing music can lower BP, but more studies are required to draw any conclusions about which treatment, Resperate or only listening to relaxing music is preferable. The result supports previous studies showing that listening to music can lower blood pressure [7,8,15]. In accordance with Logtenberg et al. [15] there was no significant difference in the change in SBP between the groups, but a significant reduction of SBP over the course of treatment in the control (CD) group. However, contrary to Logtenberg et al. [15] we found a significant reduction in DBP after 16 weeks of treatment in both groups. This could perhaps be explained by the fact that the inclusion criteria were different in the studies. Logtenberg et al. also included patients with Type 2 diabetes mellitus. Another interesting result in accordance with Logtenberg et al. [15] was that the decrease in BF did not seem to affect BP. Despite the more pronounced decrease in BF in the Resperate group, this was not followed by an obvious effect in BP.

A limitation of the present study is the small sample size. This is also the probable reason for the difference in the number of participants in the Resperate group and the CD group as neither the investigator nor the patient had any possibility to know or influence the content of the envelope or the order in which they were opened. The differences in baseline characteristics of the patients in the Resperate and CD group may be an effect of the randomization and inclusion criteria of the study. It is possible that matched groups at baseline regarding SBP, age, gender, years since diagnosis of hypertension would be preferable. We can compare our baseline characteristics with another random sample of patients ($n = 375$) with hypertension at ten other primary health care centres in Sweden and patients in the same range of age [20]. There were more females in our groups. A possible explanation is that the women were more ready to participate in the study and to test alternative methods to lower blood pressure.

The strength of the present study is the length of follow up of 16 weeks. Previous studies have followed patients for only 8 weeks [10–15]. Another finding of importance was the high adherence to

treatment in the study. Only one patient dropped out after randomization. We found that all of the patients followed the instructions thoroughly and reported that they used the Resperate and CD-player at least 3 times a week during 15 min sessions. Even though the use of the devices required more time and attention than pharmacological therapy, this type of treatment seems to be appreciated by the patients and several other studies have found good adherence. In fact, the patients wanted to keep the devices and did not want to stop using the Resperate or CD-player after conclusion of the study. A possible explanation to this high adherence may be that the patients are able to manage their own treatment, choose the time of treatment and perceive the effect immediately. Furthermore the treatment has no side effects.

That active patient participation is an important element of care for patients with hypertension and improves adherence to treatment has been suggested in previous studies [21–23]. Patients who believe that they have control over their health will probably be more active in care and take more responsibility for their own care [21]. Generally there was a positive perception of the treatment both in the Resperate and the CD group. It was interesting that only 3 of 18 patients who participated in the interviews mentioned high blood pressure reductions when asked about possible effects of the treatment. Patients preferred to talk about feelings of physical and spiritual wellbeing as an effect. Can this mean that patients believe in music as a coping method in antihypertensive treatment? It is possible that this modality of treatment facilitates patient understanding of the importance of treatment as it gives an immediate experience of relaxing, thereby increasing their participation in treatment. The lack of side effects, the demonstrated efficacy and the positive influence of wellbeing show that there may be a potential benefit for using this therapy in the care of patients with hypertension.

Conclusions

This study indicates that device-guided breathing exercises have an antihypertensive effect. Listening to relaxing music may also be of importance in lowering blood pressure. Patients were generally satisfied with the use of the device-guided breathing exercises and they seemed to perceive the treatment as a chance to influence their own health. More research is needed to draw conclusions about which treatment is preferable.

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