

# Device-Guided Breathing Exercises Reduce Blood Pressure: Ambulatory and Home Measurements

Talma Rosenthal, Ariela Alter, Edna Peleg, and Benjamin Gavish

Slow breathing practiced routinely using an interactive device has demonstrated a sustained reduction in high blood pressure (BP). We reevaluated the BP response of hypertensives ( $n = 13$ ) to this daily treatment for 8 weeks using 24-h ambulatory, home, and office BP measurements. A clinically significant BP reduction of similar magnitude was observed in all BP monitoring modalities during the daytime. Greater BP reductions were found for

older patients and higher baseline BP. The results provide additional support for the efficacy of the device as an adjunctive lifestyle modification for treating hypertension. Am J Hypertens 2001;14:74-76 © 2001 American Journal of Hypertension, Ltd.

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**T**he side effects and cost of antihypertensive drugs have led to the search for effective nonpharmacologic treatment alone or as an adjunct to drug therapy.<sup>1</sup> Recently, a randomized controlled study reported that device-guided slow breathing with prolonged expiration performed daily for 2 months resulted in a sustained office blood pressure (BP) reduction of 16.2/10.6 mm Hg from a baseline BP of 158/97 mm Hg ( $n = 65$ ).<sup>2</sup> A similar study with this device involved home BP measurements.<sup>3</sup>

Breathing exercises play a prominent role in behavioral methods such as yoga, meditation, and biofeedback, which have had some success in treating high BP.<sup>4-6</sup> There may be some rationale for the therapeutic effect of the breathing exercises, as the acute response to slow and stable breathing includes a number of beneficial effects on the cardiovascular system, both at the systemic and the microvascular level. These include increasing baroreflex sensitivity, heart rate variability, microvascular flow and venous return, and reducing BP and peripheral resistance.<sup>7-11</sup> However, some of the observed antihypertensive effect elicited by the breathing exercises may be attributed to placebo response, to which office BP measurements are sensitive, but ambulatory and home BP monitor are relatively insensitive.<sup>12,13</sup>

It is the purpose of the present study to reevaluate the efficacy of the breathing-guiding device in reducing the BP of hypertensives using 24-h ambulatory BP monitoring

and digital BP monitoring (BPM) performed at home in addition to standard office measurements.

## Methods

### Subjects

The study population included 13 hypertensives, 7 men and 6 women, 6 medicated with antihypertensive drugs with no dose change for 3 weeks before the study, and 7 unmedicated, aged 25-75 years, excluding patients with BP classified as stage III (systolic BP  $\geq 180$  mm Hg or diastolic BP  $\geq 110$  mm Hg) and unmedicated patients with normal BP ( $< 130/85$  mm Hg).

### Study Design

The study included only one treatment group. During the study a patient visited the clinic five times. Visits 1 and 2, 1 day apart, were used for eligibility and baseline office and 24-h ambulatory BP measurements. Treatment and home BP measurement took place during the next 8 weeks. One follow-up visit (No. 3) was scheduled at the end of 4 treatment weeks. Office and 24-h ambulatory BP measurements were done at the end of treatment (visits 4 and 5, 1 day apart). An assistant trained the patient in using the device and the home BP monitor during visit 2 at the clinic.

### Treatment

Treatment consisted of 15 min daily, breathing exercises performed for 8 weeks, musically guided by a device

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From the Chorley Hypertension Unit, Chaim Sheba Medical Center (TR, EP), Tel Hashomer and InterCure Ltd. (AA, BG), Neve-Tlan, Israel.

Address correspondence and reprint requests to Talma Rosenthal, MD, Chorley Hypertension Unit, Chaim Sheba Medical Center, Tel Hashomer, Israel; e-mail: talros\_il@yahoo.com

called Respi-Low (InterCure Ltd., Neve Ilan, Israel). The device consists of a belt-type respiration-movement sensor mounted on the upper abdomen or chest, attached to a computerized control unit and headphones. On the basis of an analyzed monitored breathing pattern, the device composes, in real-time, music-like sound patterns with a temporal structure similar to the actual breathing pattern but with prolonged "expiration" (in the sound pattern). The breathing pattern modification occurs as the user voluntarily follows the sound pattern with his or her breathing movements. This process continues until a steady state is reached at the lowest breathing rate comfortable for the user. The device also has a data logger that stores and displays data including date, time, and duration of use, and performance parameters for the purpose of technical help by telephone. The treatment took place at home, during the afternoon or evening. No change was made in the antihypertensive medication throughout the study period. Treatment started after visit 2 and stopped before visit 4. Devices were then collected and downloaded.

### BP Measurements

Office BP was measured in a sitting position, after the patient had rested for 5 min, using a standard procedure. The BP level for each device was taken as the average of the last two readings after three consecutive readings. Twenty-four-hour ambulatory BP was determined at frequency of four per hour using Suntech Accutracker (Suntech Medical Instruments, Raleigh, NC). The attached software provided the average BP in the awake and asleep phases. Home BP was measured with Omron IC, a digital BPM that stores all data including BP, heart rate, date, and hour up to 350 measurements without a possibility to erase or replace data by the user. Patients were instructed to measure BP in the morning three times consecutively in a comfortable sitting position after at least 5 min of rest, and to refrain from smoking, physical exercise, or caffeine during the 30 min preceding the measurement.

Subject's compliance with treatment was checked using data stored in the data logger of the Respi-Low during the study (by telephone) and after the study, when the data files were downloaded. Compliance with home BP measurements was checked by the dates and times of the measurements stored in the BPM and downloaded at visits 3 and 4.

### Data Analyses and Statistics

The study outcomes were the average systolic and diastolic BP changes from baseline level (visits 1 and 2 for the office and 24-h ambulatory) to end level (visits 4 and 5). For the home measurements study outcomes were the average daily BP in the first and last 2 weeks. Heart rate changes were defined accordingly. The primary study outcome was the 24-h ambulatory BP changes in the awake phase, as outcomes of previous studies (office BP changes) were defined at this time phase. The BP and heart rate

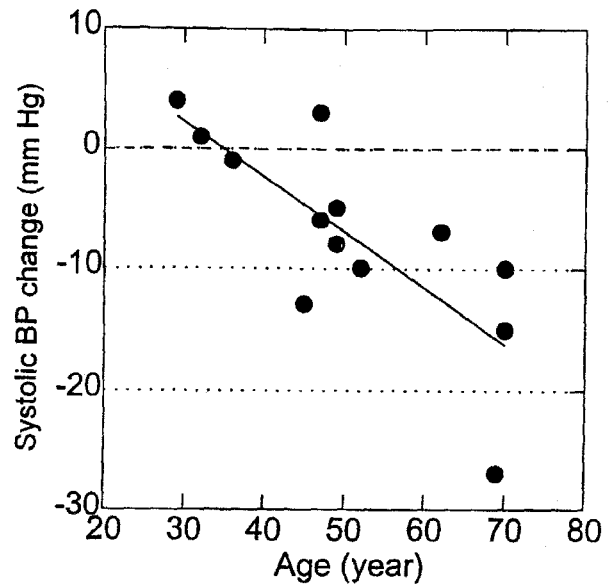


FIG. 1. Age dependence of change in 24-h ambulatory systolic blood pressure (BP) (awake) in response to treatment. Each point corresponds to an individual patient. The regression line is marked. The correlation coefficient is  $r = 0.76$  and the slope is  $-0.46$  mm Hg/year with a significance of  $P = .005$ .

changes were tested for being different from zero by one-sample  $t$  test. Dependence of BP changes on age and baseline values were determined using linear regression models, where the  $P$  values correspond to the regression coefficients (eg, the significance of a non-zero slope as illustrated in Fig. 1). All  $P$  values were two-tailed. Statistical significance was associated with  $P < .05$ .

### Results

Baseline characteristics (mean  $\pm$  SD) were age  $50.5 \pm 13.9$  years and body mass index  $25.0 \pm 5.2$ . Systolic/diastolic BP were the following: for 24-h ambulatory,  $137.1 \pm 6.9/82.5 \pm 8.4$  mm Hg for awake ( $n = 13$ ) and  $117.8 \pm 10.3/69.4 \pm 10.5$  mm Hg for asleep ( $n = 12$ ). Office BP was  $140.7 \pm 13.9/86.1 \pm 8.9$  mm Hg and home BP was  $146.4 \pm 15.4/84.8 \pm 8.3$  mm Hg. Heart rate was  $75.2 \pm 6.7$  beats/min. The number of patients at each BP classification was 1, 3, 7, and 2 for normal, high normal, stage I, and stage II, respectively.

The response to treatment is summarized in Table 1. In general, BP changes were similar in all monitoring methods. Significant systolic BP reduction was observed in the 24-h ambulatory (awake) and the office BP. There was a 73% correlation between the 24-h ambulatory home mean arterial pressure (MAP) change (defined as: diastolic + (systolic - diastolic)/3). No correlation was found between office BP changes and baseline values of either ambulatory or home BP or the difference between office and home BP, which discloses white coat effect. There was

**Table 1.** Blood pressure response to treatment

BP Monitoring Modality (n = 13)	BP Change (mm Hg)	
	Systolic	Diastolic
24-h ambulatory (awake)	-7.2 ± 2.3†	-2.3 ± 1.6
24-h ambulatory (asleep)‡	0.9 ± 4.4	-2.3 ± 2.5
Digital monitor, at home	-5.8 ± 2.6*	-3.0 ± 1.5
Mercury sphygmomanometer, at office	-7.2 ± 1.9†	-3.4 ± 1.6

BP = blood pressure.

Values represent the mean ± SEM.

\*  $P < .05$ .

†  $P < .01$ .

‡  $n = 12$  patients only.

no significant change in heart rate ( $-1.0 \pm 5.2$  beats/min) and no side effects were observed.

The BP reduction effect of the treatment was found to increase with age in the ambulatory systolic BP (awake), as shown in Fig. 1 and the corresponding MAP reduction ( $P = .02$ ). Using a similar analysis, MAP reduction at home was found to increase with age ( $P = .05$ ) and baseline home MAP ( $P = .01$ ), whereas office systolic BP reduction appears to increase for greater baseline systolic BP ( $P = .005$ ).

The contribution of age and baseline BP level can be demonstrated by calculating the MAP change for three groups: group I, all patients ( $n = 13$ ), group II, patients aged  $\geq 40$  years old ( $n = 9$ ), and group III, patients with baseline home MAP  $\geq 100$  mm Hg ( $n = 7$ ). The MAP changes obtained with ambulatory (awake), home BP and office BP were, respectively,  $-3.9$ ,  $-3.9$ , and  $-4.7$  mm Hg ( $P < .05$ ) for group I;  $-5.7$ ,  $-5.8$ , and  $-4.8$  mm Hg for group II ( $P < .05$ ); and  $-5.1$ ,  $-7.2$ ,  $-6.4$  ( $P < .01$ ) mm Hg for group III.

## Discussion

In terms of the magnitude of BP reduction by accepted lifestyle modifications,<sup>14,15</sup> the BP reduction achieved by the treatment device is clinically significant. The similarity in BP response to treatment obtained with 24-h ambulatory, home, and office measurements suggests that the BP reduction is not likely due to the placebo effect.<sup>12,13</sup> The increased BP reduction for greater age or greater baseline BP, and the absence of any significant change in the heart rate, are of considerable interest for two reasons. First, the benefits of the treatment are greater for patients found at higher risk for cardiovascular disease, older or with a higher BP. Second, these correlations may reflect a vascular property, that is, beneficially modified by the treatment, such as arterial compliance, which is reduced in older age and higher BP. However, larger sample size and other vascular probes are needed before such speculation can be applied. It is noteworthy that the difference in the

previous study can be explained quantitatively by its dependence on the baseline BP, which was higher in the previous study (see Introduction).

In conclusion, the present study provides additional evidence of the benefit of routine breathing exercises guided by the tested device as a safe and efficacious adjunctive lifestyle modification for treating hypertension.

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