Home Relaxation Techniques for Essential Hypertension

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A 10-week relaxation treatment focused on home practice and self-monitoring of blood pressure for the purpose of lowering blood pressure in patients with essential hypertension. Comparisons were made among relaxation (n = 13), relaxation in combination with electromyographic biofeedback (n = 14), and a control condition in which patients simply monitored their blood pressure (n = 14). These three groups of patients, all of which received antihypertensive medication, were compared with a fourth group that practiced relaxation without drug therapy (n = 17). Relaxation and relaxation/biofeedback were equally effective in reducing blood pressure recorded at home in the morning and evening and produced greater decreases than in the control group. Relaxation without drugs, although somewhat more effective than self-monitoring, did not reduce blood pressure as much as the two conditions in which medication was combined with relaxation. Although reductions over the course of treatment were noted in blood pressures recorded in the laboratory, the four treatment conditions did not differ significantly from one another.

Evidence from the literature has indicated that behavioral treatments can be quite effective in the control of hypertension, although the actual decline in blood pressure as a result of such treatments has varied widely from one study to the next (1–4). In a recent study of behavioral techniques, we concluded that blood pressure biofeedback can reduce blood pressure levels in patients with mild to moderate hypertension almost as effectively as drugs. However, we noted several limitations to the biofeedback procedure used. To begin with, it is a rather complex technique requiring expensive equipment and frequent laboratory visits. In addition, the benefits of training were demonstrable in the laboratory but not in home measures of pressure and did not persist very long after treatment ended. Because of these limitations, we sought to develop a procedure that could be practiced daily at home and utilized in a variety of stressful situations. The element of home practice has been considered a prime factor in successful behavioral treatments (1,3). Furthermore, a home procedure would place primary responsibility for their care upon the patients themselves, thereby requiring their active participation and giving them a feeling of more direct involvement in and control over their blood pressure. Such active participation was a major requirement of the Working Group to Define Critical Patient Behaviors in High Blood Pressure Control (5).

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The present study evaluated a home technique that combined systematic muscle relaxation, deep breathing, imagery, and the self-recording of blood pressure by the patient in the morning and immediately before and after the relaxation exercise in the evening. Although it was taught initially in the laboratory by the experimenter, primary emphasis was given to techniques that could be practiced at home with the aid of a blood pressure machine and an audiotape cassette. Tape cassette relaxation procedures have been found by others to be effective in reducing blood pressure (6,7). Our basic 10-week relaxation procedure was evaluated in patients on and off antihypertensive medication and compared to a similar procedure in which patients were also given electromyographic biofeedback training in the laboratory. A fourth group of patients simply monitored their own blood pressure twice daily at home with instructions to try to reduce the pressure. Group comparisons during the 10-week treatment program were made against a 6-week baseline and after a 1-year follow-up. Finally, success in treatment was related to demographic and personality variables.

MATERIALS AND METHODS

Selection and Description of Subjects

Patients were solicited by advertisements in local newspapers and radio announcements requesting the participation of hypertensive individuals between the ages of 35 and 62 in a program to control hypertension by means of nondrug techniques. More than 500 persons called the laboratory for information, and 335 questionnaires were sent to those who seemed to fit our basic selection criteria. Further screening of questionnaires and patients enabled us to select those patients who had been diagnosed at least 1 year previously as hypertensive with no evidence of secondary hypertension or another serious disorder such as diabetes, heart disease, or renal disorders. We excluded patients who were obese, alcoholic, taking any major drugs other than antihypertensive medication, or in psychotherapy. In addition, patients had to meet all of the requirements of the study and obtain permission to participate from their private physicians, who supplied us with medical records on the patients. Further confirmation of the nature of the patients' eligibility and hypertensive status was obtained by our staff physician, who saw the patients individually.

Although 108 patients were selected at prebaseline assessments, patient loss occurred at different phases of the study. When patients were reassessed 1 month later during the baseline phase, 24 were rejected because their average diastolic pressures had dropped below 90 mm Hg in the laboratory and/or their average home baseline pressures were below 85 mm Hg. Eight additional patients were excluded because they did not comply with home-recording requirements. Two had blood pressures that were too high, one could not tolerate use of the cuff, and one could not obtain accurate measurements of blood pressure at home. Further losses during the actual treatment phase included 14 patients. Of these patients, five were in the relaxation group, five in the relaxation/nondrug group, three in the relaxation/biofeedback group, and one in the self-monitoring group.

The actual patient sample finishing the treatment phase included 41 patients who had been on a consistent antihypertensive medication schedule for at least 6 months before beginning the study and 17 patients who had discontinued medication on their own at least 6 months before participation in the study. Patients had stopped taking medication either because it had no effect on their blood pressure or because of disturbing side effects. A description of the 58 patients in the study and their distribution in the different groups is shown in Table 1.

Assessment and Procedures

Prebaseline Assessments. Initial visits to the laboratory were made on three different days over a period of 2 weeks. At this time patients were familiarized with the laboratory and given an opportunity to ask questions about the study. On each occasion and all subsequent occasions in the laboratory, three separate blood pressure determinations were made with a mercury sphygmomanometer after the patient had been seated quietly in an upright position for 10

TABLE 1. Description of Patient Sample

Characteristic	Relaxation	Relaxation/ biofeedback	Relaxation/ nondrug	Self-monitoring
Sex				
Male	10	11	13	12
Female	3	3	4	2
Mean age (yr)	53.9 ± 5.35	52 2 ± 5.33	53.2 ± 7.55	52.8 ± 7.22
Race				
White	12	13	17	13
Black	1	1	0	1
Marital status				
Married	12	12	12	11
Divorced	1	2	3	2
Single	0	0	1	0
Widowed	0	0	1	1
Mean no. of children	2.2 ± 1.37	2 3 ± 0.83	2.2 ± 1.79	2.4 ± 1.50
Occupation				
Skilled	6	8	9	7
Professional	6	6	7	6
Housewife	1	0	1	1
Education				
12th Grade	2	2	3	3
Junior college	4	4	2	3
College (4 yr or more)	7	8	12	8
Mean exercise (hr/week)	5.1 ± 7.84	5.8 ± 8.38	7.8 ± 6.89	3.0 ± 2.66
Special diet	6	4	3	5
No. of smokers	2	0	2	3
Mean history of hypertension (yr)	11.7 ± 8.82	8.9 ± 10.71	3.4 ± 2.89	10.3 ± 6.82
Family history of hypertension	11	10	9	6

min in a lounge chair. All blood pressure measurements were recorded from the left arm. If blood pressure appeared to be dropping rapidly (at least 5 mm Hg), two additional measures were recorded. A 1-min pulse rate was also recorded.

Patients were also instructed in the use of electronic sphygmomanometers[1] for the recording of daily blood pressure readings at home under standard conditions. Each time they returned to the laboratory, their use of the device was checked. They were asked to record three blood pressure measurements and a pulse rate upon awakening and in the evening at least 1 hr after eating. Daily measurements were recorded on forms, which the patients mailed back to the laboratory twice a week in stamped envelopes. Medication usage, food intake, alcohol consumption, and any unusual stressor or change in life-style were also indicated on the forms.

At the end of the third prebaseline session the following psychologic tests were administered: the Spielberger State–Trait Anxiety Scale (8); the Jenkins Activity Survey (9); the Recent Life Changes Questionnaire (10); and the Hostility and Direction of Hostility Questionnaire (11).

Baseline Measurements. After patients had recorded home blood pressures for 1 month, they were

[1]Hemo-Sphyg no. 221, available from Nelkin Medical Products, Ltd., 815 Wyandotte Street, Kansas City, MO 64105. This device was selected after extensive testing of various electronic sphygmomanometers. Its readings were found to be most comparable to those obtained with a mercury manometer. In addition, the device was rechecked against the mercury manometer each time patients visited the laboratory.

asked to return to the laboratory for three baseline sessions within a period of 2 weeks. At each session patients sat quietly for 10 min, followed by three blood pressure determinations and a measurement of pulse rate, 15 min more of quiet sitting, and three final blood pressure determinations and a recording of pulse rate. During the 2 weeks that patients were coming to the laboratory, they continued to monitor morning and evening blood pressures, thereby providing a total of 6 weeks of blood pressure measurements at home.

Treatments

After the completion of baseline measurements, patients who were taking antihypertensive medication were assigned to relaxation (n = 13), relaxation/biofeedback (n = 14), or self-monitoring (n = 14); the three groups were similar with regard to age, sex, race, and average laboratory baseline blood pressure. In addition, attempts were made to equate the groups as much as possible for type of antihypertensive medication (Table 2). All patients who were not taking any medication were placed in a relaxation/nondrug group (n = 17). When the group was more than one-half filled, we selected patients from the waiting list to make this group similar to the other three groups.

Drug compliance was checked on the daily forms that patients used to record their blood pressure measurements at home. The forms indicated medication taken that day. Only an occasional failure to use the prescribed medication was reported, and compliance was comparable in all three groups and did not change during the treatment phase.

TABLE 2. Antihypertensive Medications in Three Drug Groups

Medication	RL	RL/BF	SM
Diuretic	4	5	4
β-Blocker	2	2	2
Diuretic and β-blocker	1	1	1
Clonidine	1	0	2
Clonidine and diuretic	1	2	1
Methyldopa	1	1	1
Vasodilator and diuretic	1	1	1
Combination of three drugs with different actions	2	2	2

Abbreviations: RL = relaxation (n = 13); RL/BF = relaxation/biofeedback (n = 14); SM = self-monitoring (n = 14).

All patients, regardless of treatment modality, continued monitoring their blood pressure at home twice a day (three measurements each time). They reported to the laboratory twice a week during the first week and once every 2 weeks thereafter, for a total of seven sessions. Appointments were made so that each patient's laboratory session was always at the same time of day. The sessions began with 10 min of rest, followed by three blood pressure recordings, a pulse rate reading, the treatment procedure (about 20 min), three final blood pressure measurements, and a final pulse reading. Patients were given feedback on their blood pressure at the end of each set of three readings. Home blood pressure machines were checked each time patients came for appointments. The progress of all patients was discussed at the close of each session. They were encouraged to continue practicing their treatment procedure, praised for any decreases in blood pressure at home or in the laboratory, and told that with continued practice blood pressure readings would show a downward trend.

After the fifth treatment session all patients were shown a graph of morning and evening home blood pressure readings obtained from an actual pilot relaxation subject. Very impressive blood pressure reductions were indicated over 2-week intervals at baseline, treatment, and 4 months of follow-up. Patients were told that these changes in blood pressure were effected by a treatment similar to theirs and that with continued practice they could achieve such results.

During the latter part of treatment session 7, the Life Changes Questionnaire and the Spielberger State–Trait Anxiety Scale were readministered. In addition, the experimenter evaluated each patient's response to treatment by asking a series of questions about the treatment.

The four treatment groups were as follows:

Self-Monitoring. Although the monitoring of blood pressure at home twice daily was a condition common to all groups, in the self-monitoring group it was regarded as the only treatment. When patients reported to the laboratory, blood pressure and pulse rate were monitored by the experimenter before and after patients sat quietly by themselves for 15 min. Emphasis in this group was on keeping track of blood pressure levels and trying to lower blood pressure through awareness. The blood pressure machine was compared to a biofeedback machine that made patients aware of their own pressures.

Relaxation. Patients were trained to relax in the laboratory by means of a procedure that, like Jacob-

son's progressive relaxation (12), focused on the systematic relaxation of various muscles of the body, beginning with the feet and progressing up to the muscles of the head and face. Unlike progressive relaxation, however, the procedure did not include the tensing of muscles. Instead, patients were to take slow, deep breaths and to imagine scenes that they felt to be pleasant and relaxing. They were also told that many people who have hypertension are unable to relax, which is reflected in higher blood pressure. The primary goal during the relaxation process was to try to decrease pressures from the beginning to the end of the relaxation procedure.

In addition to practicing the relaxation procedure in the laboratory with the experimenter, patients were given a 20-min audiotape cassette of the procedure to utilize each day at home during the time when they had previously been monitoring their evening blood pressure. The relaxation was to be done in a comfortable sitting position in a place with as few distractions as possible. Patients were to keep track of their blood pressure and try to lower it as much as possible during the exercise. Included on the tape were instructions for recording three pre- and postrelaxation blood pressures and a pre- and postrelaxation pulse rate. This information was to be written on a special form, which patients were to send to the laboratory twice weekly with their morning blood pressure forms. In addition, they were asked to rate their relaxation on a scale from 1 to 10, where 10 equaled the highest degree of relaxation and 1 the lowest. They were also requested to record any unusual events that occurred during the day.

When patients came for their fourth treatment, they were given a second audiotape cassette to use every other evening. This tape (called the *blank tape*) provided initial and final instructions for recording blood pressure but nothing else. The patients were told to perform the relaxation exercise on their own during the 20-min interim. At treatment session 5, after it was believed that patients had adequately learned the relaxation procedure, they were told that it was only necessary to utilize the full tape once a week just to refresh themselves on the procedure. At all other times, they could practice with the blank tape. Patients were also encouraged to practice the relaxation exercise during the day whenever they were in a stressful situation.

Relaxation/Nondrug. Patients in the relaxation/nondrug group followed all of the procedures required of the relaxation group. The only difference between the two was the absence of medication in the relaxation/nondrug group.

Relaxation/Biofeedback. Patients in the relaxation/biofeedback group followed the same procedures as the relaxation groups during the first two treatment sessions. After 1 week of monitoring morning pressures and relaxing with the tape cassette each evening, they returned to the laboratory for session 3 and their first biofeedback treatment. During this session initial pressures and pulse rate were recorded, electromyogram electrodes were applied to the frontalis muscle, and the patient was guided through the standard relaxation procedure. The experimenter then tried to obtain even deeper relaxation by using a shaping procedure to reduce the activity of the frontalis muscle. Auditory clicks were produced by the Cyborg J-33, and the patient was instructed to try to reduce both the amplitude and the frequency of the clicks. The entire procedure with relaxation and biofeedback took approximately 25 min and was continued through session 7. Home procedures and the use of regular and blank tapes were the same as in the relaxation groups.

Follow-up

Patients were asked to continue with the same home procedures followed during the treatment phase for 1 year after treatment ended and to return to the laboratory once a month for recording of blood pressure and pulse rate and for checking their blood pressure machines. During the first follow-up visit they were also shown a graph of their blood pressures at home and in the laboratory from baseline to end of treatment, averaged over 2-week intervals. Patients who showed declines in blood pressure were praised: those with few reductions were assured that their pressure would drop with continued practice. The Life Changes Questionnaire, the Spielberger State–Trait Anxiety Scale, and an interview evaluating the patient's response to treatment were readministered at the end of 6 months and again at the end of 12 months.

RESULTS

Blood Pressure Measurement at Home

Morning Pressures. Morning blood pressure was averaged over the last 2 weeks of baseline (weeks 5 and 6) and compared with pressures taken at home in the morn-

ing during the last 2 weeks of treatment. The changes resulting from the various treatments were analyzed by means of an analysis of variance of group (relaxation,relaxation/biofeedback, relaxation/nondrug, and self-monitoring) × treatment phase (baseline and end of treatment) design (Table 3). Separate analyses were computed for systolic and diastolic blood pressure. The main effect for treatment phase was significant for systolic blood pressure ($F(1,54) = 21.29$, $p < 0.0001$) and diastolic blood pressure ($F(1,54) = 23.62$, $p < 0.0001$). The group × treatment phase interaction was also significant for systolic ($F(3,54) = 8.24$, $p < 0.0001$) and diastolic blood pressure ($F(3,54) = 3.61$, $p < 0.02$).

The significant interaction is apparently due to the differing effects of the treatments in each of the groups. From baseline to end of treatment systolic blood pressure showed decreases of 8.6 mm Hg for relaxation, 7.6 mm Hg for relaxation/biofeedback, and 3.8 mm Hg for relaxation/nondrug and an increase of 3.2 mm Hg for self-monitoring. The results of Newman–Keuls a posteriori tests (13) indicated that all three relaxation groups were significantly different from the self-monitoring group ($p < 0.01$). For diastolic blood pressure self-monitoring showed an increase of 0.4 mm Hg, whereas for the other groups the decreases were as follows: relaxation, 4.0 mm Hg; relaxation/biofeedback, 4.7 mm Hg; and relaxation/nondrug, 3.7 mm Hg. As with systolic blood pressure, a posteriori tests revealed that all relaxation groups were significantly different from the self-monitoring group ($p < 0.01$) but did not differ among themselves.

Evening Pressures. Blood pressure recorded at home during the evening hours of the last 2 weeks of baseline was compared with that measured by the patient in the evening before the relaxation exercise during the last 2 weeks of treatment (Table 4). An analysis of variance of group × treatment phase (baseline and end of treatment) revealed a significant treatment phase effect for systolic ($F(1,54) = 11.78$, $p < 0.002$) and diastolic blood pressure ($F(1,54) = 22.47$, $p < 0.001$) and significant group × treatment phase interactions for systolic ($F(3,54) = 5.14$, $p < 0.004$) and diastolic blood pressure ($F(3,54) = 2.95$, $p < 0.04$). Again, the specific treatments had differing effects on blood pressure, with self-monitoring exhibiting a systolic increase of 1.9 mm Hg from baseline to end of treatment and relaxation, relaxation/biofeedback, and re-

TABLE 3. Effects of Treatment on Morning Measurement of Blood Pressure at Home[a]

	Systolic blood pressure		Diastolic blood pressure	
Treatment group	Baseline	End of treatment	Baseline	End of treatment
Relaxation	136.4 ± 13.5	127.8 ± 11.6	88.8 ± 7.4	84.8 ± 6.8
Relaxation/biofeedback	135.9 ± 14.8	128.3 ± 13.5	93.4 ± 6.1	88.7 ± 8.3
Relaxation/nondrug	138.9 ± 9.5	135.1 ± 10.0	93.8 ± 6.9	90.1 ± 6.7
Self-monitoring	129.3 ± 15.0	132.5 ± 15.0	88.2 ± 4.3	88.6 ± 6.0

[a]Blood pressure values (mm Hg) are expressed as means ± standard deviations. Recordings were taken by patients each morning during the last 2 weeks of baseline and the last 2 weeks of treatment.

TABLE 4. Effects of Treatment on Evening Measurement of Blood Pressure at Home[a]

Treatment group	Systolic blood pressure			Diastolic blood pressure		
		End of treatment			End of treatment	
	Baseline	Before	After	Baseline	Before	After
Relaxation	136.3 ± 14.0	129.4 ± 17.6	124.0 ± 15.4	87.4 ± 7.7	82.6 ± 6.5	80.8 ± 7.2
Relaxation/ biofeedback	133.1 ± 12.1	124.1 ± 13.8	120.3 ± 14.7	91.0 ± 5.3	84.9 ± 7.9	83.3 ± 7.7
Relaxation/ nondrug	135.4 ± 9.7	134.5 ± 10.1	129.6 ± 10.8	90.2 ± 6.4	87.5 ± 6.2	86.0 ± 7.9
Self-monitoring	129.8 ± 13.2	131.5 ± 17.8		86.8 ± 4.4	86.5 ± 6.0	

[a]Blood pressure values (mm Hg) are expressed as means ± standard deviations. Recordings were taken by patients each evening during the last 2 weeks of baseline and the last 2 weeks of treatment before relaxation and immediately after relaxation. For the self-monitoring group, only initial pressures (before relaxation) were recorded.

laxation/nondrug showing decreases of 6.9, 9.0, and 9.0 mm Hg, respectively. The results of the Newman–Keuls tests indicated that relaxation/biofeedback was significantly different from self-monitoring and relaxation/nondrug ($p < 0.01$) and that relaxation was significantly different from self-monitoring ($p < 0.01$) and relaxation/nondrug ($p < 0.05$). Similar results were found for diastolic blood pressure, with decreases of 4.8 mm Hg for relaxation, 6.1 mm Hg for relaxation/biofeedback, 2.6 mm Hg for relaxation/nondrug, and 0.3 mm Hg for self-monitoring. A posteriori tests indicated that both relaxation and relaxation/biofeedback were significantly different from self-monitoring ($p < 0.01$). No other group differences were significant. A frequency table of individual changes in blood pressure is shown in Table 5.

To determine whether or not the within-session changes in blood pressure (pre- and postrelaxation blood pressures, Table 4) were significant for the three groups practicing relaxation, a t test was computed on the pre- and postrelaxation scores (for all three groups together). The change in systolic pressure from 129.7 to 125.0 mm Hg during the last 2 weeks of treatment was found to be significant ($t(43) = 6.83$, $p < 0.01$), as was the decrease in diastolic pressure from 85.2 to 83.6 mm Hg ($t(43) = 2.98$, $p < 0.01$). No within-session changes could be determined for the self-monitoring group, as patients in this group only took one set of blood pressure readings in the evening.

Blood Pressure Measurement in Laboratory

The laboratory data for all groups consisted not only of blood pressure measurements at baseline and at the end of treatment, but of those at the beginning and end of each session as well. To analyze the effects of blood pressure on all of these conditions, a three-way analysis of variance was performed, comparing groups (relaxation, relaxation/biofeedback, relaxation/nondrug, and self-monitoring) × treatment phase (baseline and end of treatment) × within-session changes (before and after relaxation) on the systolic and diastolic data in Table 6. There were no significant effects involving groups. For systolic blood pressure the effects of

TABLE 5. Summary of Changes in Blood Pressure from Baseline to End of Treatment

	Systolic blood pressure				Diastolic blood pressure			
Finding	RL	RL/BF	RL/ND	SM	RL	RL/BF	RL/ND	SM
Home, morning								
No change or increase	0	3	4	11	2	3	3	8
1–4 mm Hg change	3	2	5	1	2	4	7	4
5–9 mm Hg change	4	3	5	2	7	3	6	2
10–14 mm Hg change	5	3	3	0	1	4	1	0
>14 mm Hg decrease	1	3	0	0	1	0	0	0
Percentage with at least 5 mm Hg change	77	64	47	14	69	50	41	14
Home, evening								
No change or increase	3	3	10	8	3	3	7	6
1–4 mm Hg change	2	2	1	4	1	2	3	6
5–9 mm Hg change	3	3	5	2	7	7	5	2
10–14 mm Hg change	2	3	0	0	1	0	1	0
>14 mm Hg decrease	3	3	1	0	1	2	1	0
Percentage with at least 5 mm Hg change	62	64	35	14	69	64	41	14
Laboratory								
No change or increase	6	4	3	7	5	3	6	6
1–4 mm Hg change	0	2	6	2	1	3	5	5
5–9 mm Hg change	3	3	3	2	4	5	5	2
10–14 mm Hg change	0	3	3	1	1	2	0	1
>14 mm Hg decrease	4	2	2	2	2	1	1	0
Percentage with at least 5 mm Hg change	54	57	47	36	54	57	35	21

Abbreviations: RL = relaxation (n = 13); RL/BF = relaxation/biofeedback (n = 14); RL/ND = relaxation/nondrug (n = 17); SM = self-monitoring (n = 14).

TABLE 6. Effects of Treatment on Measurement of Blood Pressure in Laboratory[a]

Treatment group	Systolic blood pressure				Diastolic blood pressure			
	Baseline		End of treatment		Baseline		End of treatment	
	Before	After	Before	After	Before	After	Before	After
Relaxation	146.8 ± 8.2	141.1 ± 8.6	141.5 ± 14.3	134.7 ± 15.5	99.1 ± 5.2	96.1 ± 5.6	95.5 ± 8.4	93.1 ± 6.0
Relaxation/ biofeedback	144.6 ± 12 0	140.9 ± 10.5	140.1 ± 13.8	134.9 ± 13.0	99 7 ± 6 9	97.0 ± 6.7	94.7 ± 8.6	94.1 ± 7 5
Relaxation/ nondrug	147 5 ± 10.0	144.3 ± 8.4	143.5 ± 10.7	139.1 ± 11.3	99.1 ± 5.5	98.4 ± 5.5	96.2 ± 6.3	95.6 ± 7.0
Self-monitoring	145.7 ± 14.0	142.2 ± 13.7	145.0 ± 14.8	138.4 ± 14.8	98 5 ± 4.0	98.3 ± 3.5	96.3 ± 6.6	95.6 ± 8.1

[a]Blood pressure values (mm Hg) are expressed as means ± standard deviations. Values during baseline represent means for three baseline days at the beginning of the session (Before) and after 15 min of sitting quietly (After). Values for end of treatment represent means taken at the beginning (Before) and the end (After) of treatment session 7.

treatment phase were significant ($F(1,54) = 9.37$), $p < 0.003$), as were those within sessions ($F(1,54) = 73.73, p < 0.0001$). Similarly, the analysis of diastolic pressure indicated significant effects across treatments ($F(1,54) = 8.65$, $p < 0.005$) and within treatments ($F(1,54) = 26.52$, $p < 0.001$). Presession laboratory changes from baseline to end of treatment for individual patients are indicated in Table 5.

Pulse Rate

Data on morning and evening pulse rates were analyzed by means of group × treatment phase analyses of variance in a manner similar to that used for the blood pressure data. In addition, the laboratory data were also viewed similarly to the blood pressure data with a group × treatment phase × within-session analysis of variance design. The data are not presented here, because neither the main nor the interaction effects were significant.

Variables Related to Success in Treatment

To obtain a measure of treatment success, for each patient in the three relaxation groups the blood pressure averages obtained during the last 2 weeks of treatment were subtracted from those obtained during the last 2 weeks of baseline. As a result, the patients with the highest scores had the greatest reductions in blood pressure and could be considered to have achieved the most success with relaxation. Separate scores were obtained for morning systolic, morning diastolic, evening systolic, and evening diastolic but not for laboratory blood pressure, as there were no differential treatment effects for laboratory measures. Each of these scores for change in blood pressure (for the 44 patients) was correlated with the following variables: age, amount of exercise, average relaxation rating during evening relaxation, the Hostility and Direction of Hostility Questionnaire, the Jenkins Activity Scale, and two separate administrations (baseline and end of treatment) of the Recent Life Changes Questionnaire and the Spielberger State–Trait Anxiety Scale. In addition, a compliance score was obtained by counting the total number of times individuals recorded their blood pressures at home and did their evening relaxation exercises during baseline and treatment. This score was also correlated with scores for change in blood pressure. Of the resulting Pearson correlations, only one was found to be significant: a correlation of -0.34 ($p < 0.05$) between evening change in systolic pressure and the second administration of the Recent Life Changes Questionnaire.

In an attempt to relate change in blood pressure to some of the dichotomous variables derived from the questionnaire data, we computed a series of χ^2 analyses. The major independent variable was change in blood pressure (greater than 5 mm Hg) versus no change (less than 5 mm Hg) obtained for morning and evening systolic and diastolic blood pressures. Each of these measures was analyzed against the following: presence or absence of family history of hypertension, education (more or less than 4 years of college), duration of hypertension (more or less than 10 years), and professional versus skilled occupation. None of the resulting χ^2 analyses was significant; however, family history of hypertension versus change in morning diastolic blood pressure just missed significance ($p < 0.053$) with a χ^2 value of 3.77.

TABLE 7. Summary of Changes in Blood Pressure from Baseline to End of 1-Year Follow-up

	Systolic blood pressure				Diastolic blood pressure			
Finding	RL	RL/BF	RL/ND	SM	RL	RL/BF	RL/ND	SM
Home, morning								
No change or increase	1[a]	2(1[a],1[b])	2	6	2	1[a]	1	3
1–4 mm Hg change	0	1	2	2	1	3([b])	7	3
5–9 mm Hg change	1	2(1[b])	4	0	2(1[a])	4(1[a],1[b])	2	1
10–14 mm Hg change	2	5(1[a],1[b])	3	0	0	3(1[b])	2	1
>14 mm Hg decrease	2	1	1	0	1	0	0	0
Home, evening								
No change or increase	1[a]	2(1[a],1[b])	4	4	3(1[a])	1	3	2
1–4 mm Hg change	1	2	3	1	2	2(1[a],1[b])	4	2
5–9 mm Hg change	1	1[b]	1	2	0	4(1[a])	3	3
10–14 mm Hg change	1	3(1[b])	4	1	0	4(2[b])	2	0
>14 mm Hg decrease	2	3(1[a])	0	0	1	0	0	0
Laboratory								
No change or increase	3(1[a])	6(2[a],2[b])	3	2	0	4(2[a])	4	1
1–4 mm Hg change	0	0	1	3	1	3(1[b])	1	0
5–9 mm Hg change	1	0	2	0	3(1[a])	0	4	3
10–14 mm Hg change	1	0	2	1	1	0	1	1
>14 mm Hg decrease	1	4	4	2	1	4	2	3

Abbreviations: RL = relaxation (n = 6); RL/BF = relaxation/biofeedback (n = 11); RL/ND = relaxation/nondrug (n = 12); SM = self-monitoring (n = 8).
[a]Drug dosage reduced.
[b]Drug therapy discontinued.

Of patients who showed a decrease in diastolic pressure of more than 5 mm Hg, 82% had a family history of hypertension; of those with decreases in diastolic pressure of less than 5 mm Hg, only 54% had a family history of hypertension. As baseline blood pressures of patients with and without a family history of hypertension did not differ from each other, the results appear to be due primarily to treatment effects.

Evaluation of Patient's Feelings about Treatment

The belief that blood pressure had decreased was expressed by the following groups: relaxation, 77%; relaxation/biofeedback, 79%; relaxation/non-drug, 71%; and self-monitoring, 57%. An additional 7% of those in the relaxation/biofeedback group, 12% in the relaxation/nondrug group, and 21% in the self-monitoring group modified their remarks by saying that blood pressure dropped only slightly. The remaining patients claimed that their pressures rose or stayed the same. In addition, 11 of 13 patients in the relaxation group, all 14 in the relaxation/biofeedback group, and 15 of 17 in the relaxation/nondrug group claimed that relaxation helped them to lower their blood pressure. Patients in the relaxation groups added the following unsolicited information about their treatment: Four patients believed that the relaxation exercise helped them to sleep better; three believed that it helped them to avoid stress; and one claimed that it helped to reduce headaches. In the self-monitoring group ($n = 14$), nine patients believed that the blood pressure machine increased their awareness, whereas three others said that it gave them peace of mind because they did not have to worry so much about their blood pressure.

Follow-up

Patient blood pressures at the end of 1 year of follow-up are summarized in Table 7. In general, trends toward the decrease in blood pressure have continued for all groups, with the relaxation groups showing the greatest decreases in blood pressure during morning and evening hours at home. It should also be noted that at the end of the 1-year follow-up one patient in the relaxation group and two in the relaxation/biofeedback group had their medication requirements reduced, and three patients in the relaxation/biofeedback group were taken off of drugs entirely by their private physicians. All of these results are based upon patients still remaining in the study at the end of 1 year. The numbers of patients are as follows: relaxation, 6; relaxation/biofeedback, 11; relaxation/nondrug, 12; and self-monitoring, 8.

DISCUSSION

Our results indicate that a behavioral program for hypertension that combines systematic relaxation of muscle groups, imagery, deep breathing, self-monitoring of blood pressure by the patient, and constant encouragement can result in significant reductions in blood pressure at home over the course of 10 weeks of treatment. The effects of the relaxation technique were less apparent in the laboratory, where reductions in blood pressure from baseline to end of treatment, although significant, were not as great and were not differentiated between groups. Similar results were obtained by Glasgow et al. (14), who found

that blood pressure determinations by their behaviorally treated hypertensive patients differed from those by controls on home recordings but not on professionally determined measures taken at a clinic. There are certain similarities between that study and the present study in that both were concerned with daily practice of behavioral techniques. As the primary emphasis of the present study was on the development of home techniques and home practice, it is not too surprising that major reductions in blood pressure occurred at home. Our previous study of behavioral methods, which focused on laboratory techniques, revealed that blood pressure biofeedback was primarily effective in reducing blood pressures in the laboratory, but not at home (15).

The relaxation and relaxation/biofeedback groups, although not significantly different from one another, did exhibit larger reductions in blood pressure than the group of patients for whom self-monitoring was the only treatment. Although the decreases were not as large as those obtained by Patel (16), the baseline levels in this study are much lower than those of Patel's sample of patients. The present results are, however, in accordance with the reductions attained in most relaxation/medication studies (3). Furthermore, if one looks at these changes on an individual basis, a substantial percentage of patients in the relaxation and relaxation/biofeedback groups exhibited decreases of at least 5 mm Hg in blood pressures recorded at home.

Although both relaxation and relaxation/biofeedback were effective in reducing blood pressure at home, one may question why the electromyographic biofeedback did not add much to the effects of relaxation. Glasgow et al. (14) reported that relaxation and biofeedback were more effective than either treatment alone. However, their treatments were given in sequence rather than simultaneously as in the present study, and blood pressure rather than electromyographic biofeedback was employed. It may well be that the patients in the present study had learned to relax sufficiently on their own without the added benefits of the electromyographic biofeedback. The crucial element in producing reductions in blood pressure in many relaxation and biofeedback studies has been claimed to be the daily home practice by patients (3,17). This home practice plus the addition of blood pressure information may have been enough to lower blood pressure in both groups of patients, with the addition of electromyographic biofeedback being unnecessary. It is also possible that the five electromyographic feedback sessions were not sufficient to have a major effect on blood pressure. Had the electromyographic feedback been utilized at home on a daily basis with the relaxation exercise, the relaxation/biofeedback group might have exhibited even greater reductions in blood pressure than was evident in this study.

The relaxation exercise had the effect of reducing blood pressure at home in the relaxation/nondrug group, but these reductions were not as marked as those in the relaxation and relaxation/biofeedback groups, which received medication. It may be that the combination of drugs and behavioral treatments had some additive effect that resulted in greater control of blood pressure than either treatment alone. The results of Glasgow et al. (14) seem to suggest the opposite, however, as their behavioral treatments were most effective for patients who were not taking any antihypertensive medication. The two studies are

not really comparable, as the patients on antihypertensive drugs in the present study used several kinds of medication, the sites of action of which were quite varied. Not enough is known about the complex interaction between behavioral treatment and drugs to make any definitive statement at present.

In trying to relate individual differences to amount of change in blood pressure resulting from the relaxation treatments, very little was found to be significant. This observation is in keeping with Tarler-Benlolo's (17) review of behavioral studies in which she reported no significant relationship between any personality data and performance under biofeedback or relaxation training conditions. The one correlation of 0.34 between evening change in systolic pressure and the Life Changes Scale, which could have resulted from chance, does, however, concur with the results of Luborsky et al. (18). These investigators reported that patients who had the smallest changes in blood pressure as a result of behavioral treatment were those undergoing the greatest life change or amount of stress. Another area that showed some relationship to change in blood pressure was family history of hypertension. Although not quite reaching significance, there was a tendency for patients with a family history of hypertension to show the greatest reductions in blood pressure. Family history is an important variable (4) that could serve as a motivating factor in lowering blood pressure in patients whose parents have hypertension.

In looking at the self-monitoring group, it may be argued that the failure of this group to achieve larger reductions in blood pressure at home may have been due to their lower baseline pressure (albeit not significantly) compared with that of the relaxation groups. Although this lower level may have had some effect on systolic blood pressure, it certainly did not with regard to diastolic blood pressure. However, to determine the precise influence of the lower systolic pressures on the amount of change, average baseline level of morning systolic blood pressure was correlated with the change in systolic pressure from baseline to end of treatment for all 58 patients. The resulting correlation of 0.37, although significant ($p < 0.01$), was rather small and accounted for only about 14% of the variance.

One may further question the results of the self-monitoring group by asking if these patients expected their blood pressure to drop to the same extent as in the relaxation groups. From the results of a recent study by Agras et al. (19), it is known that expectations of decreases in blood pressure definitely affect such reductions. To rule out differing expectation effects, we told the self-monitoring patients to utilize the blood pressure machine as a biofeedback device to lower their blood pressure and that continued monitoring of pressure would lead to eventual reductions. This expectation was further reinforced by showing the patients the graph of a successful pilot subject and telling all patients that they could expect similar results. In fact, at the end of treatment 70% of the subjects in the self-monitoring group believed that there was some decrease in their blood pressure since beginning the program. It should be pointed out that patients were not necessarily making the same comparisons that we were and were often comparing changes at the end of treatment with their pressures at the very start of the program (prebaseline).

Although the self-recording of blood pressure was not as effective in reducing

blood pressure as the relaxation techniques, it apparently made patients more aware of their pressure and may have increased their drug compliance. Our results showed that systolic blood pressures in the laboratory dropped from baseline to end of treatment by at least 5 mm Hg in 3.6% of the patients in the self-monitoring group. Furthermore, after 1 month of monitoring blood pressures at home during baseline, diastolic pressures were reduced in 24 patients to the extent that those measured in the laboratory were below 90 mm Hg and/or those measured at home were below 85 mm Hg. Carnahan and Nugent (20) found that self-monitoring served to lower the blood pressure of hypertensive patients by providing them with a form of feedback. Glasgow et al. (14) also showed that the monitoring of blood pressure could be an effective procedure in lowering the blood pressure of hypertensive patients and have suggested the use of self-monitoring in conjunction with professional monitoring as an initial stage in the control of borderline hypertension.

Although blood pressure was affected by the treatments, pulse rate showed no changes at all. These results are consistent with our earlier work (15) showing that biofeedback had an effect on blood pressures in the laboratory but did not affect heart rate, muscle tension, or galvanic skin response. Similarly, Seer and Raeburn (21) reported that pulse rates obtained during relaxation and control conditions did not differ either within session or between groups.

There are indications that as long as the relaxation exercise is practiced at home, reductions in blood pressure continue to remain low. This finding is shown in Table 7 by the numbers of patients whose pressures at the end of 1 year of follow-up are at least 5 mm Hg below their baseline levels. It is also interesting to note that five patients in the relaxation/biofeedback group and one in the relaxation group have had their antihypertensive medication either discontinued or reduced in dosage, in contrast to not a single subject in the self-monitoring group. The one puzzling characteristic of the follow-up data is the unequal loss of subjects in each group, the greatest loss occurring in the relaxation group. This finding becomes even more confusing when one considers that the seven patients in the relaxation group who dropped out during follow-up all had decreases in blood pressure of more than 5 mm Hg at the time that they dropped out. Relaxation, in general, although quite effective in reducing blood pressure, requires a time commitment from each subject. Even self-monitoring alone requires that the patient monitor morning and evening pressure for a considerable length of time. Apparently relaxation procedures as well as self-monitoring are only effective if patients are sufficiently motivated to practice them.

SUMMARY

A home technique that combines systematic muscle relaxation, deep breathing, imagery, and the self-recording of blood pressure by the patient before and after relaxation was studied in subjects with essential hypertension (age, 35–62 years). Blood pressures were recorded by the patients at home in the morning and evening during 6 weeks of baseline, 10 weeks of treatment, and 1 year of follow-up. Comparisons were made among the basic relaxation procedure ($n = 13$), relaxation combined with electromyographic biofeedback ($n = 14$), and a control condition

in which patients simply monitored their blood pressure ($n = 14$). All three of these groups were receiving antihypertensive medication and were compared with a fourth group of patients who practiced the basic relaxation procedure without any drug therapy. Relaxation and relaxation/biofeedback were equally effective in the reduction of blood pressure at home by the end of treatment and produced decreases greater than those in the control group. Relaxation without drugs, although somewhat more effective than self-monitoring alone, did not reduce blood pressure as much as the combination of relaxation and medication. Blood pressure recorded by the experimenter during laboratory sessions decreased over treatment, but the four treatment conditions were not significantly different from one another. In trying to relate individual differences to amount of change in blood pressure resulting from relaxation treatments, very little was found to be significant.

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