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BREATHING AWARENESS AS A RELAXATION METHOD IN CARDIAC REHABILITATION

Jan van Dixhoorn[1] and Hugo J. Duivenvoorden[2]

[1]St. Joannes de Deo Hospital
Haarlem, The Netherlands

[2]Erasmus University Rotterdam
Rotterdam, The Netherlands

INTRODUCTION

Opinions differ as to the feasibility and utility of relaxation therapy for cardiac patients. Although it seems obvious that relaxation is helpful for reducing stress in the recovery period after acute myocardial infarction (l-5), as well as for changing risk behavior (6, 7), its usage in cardiac rehabilitation is limited and variable. Only in West-Germany, it seems, is relaxation offered in all rehabilitation centers, mainly as autogenic training classes (5). In the Netherlands, application for admission is rapidly increasing, up to about 50% for all centers (8). Cardiac patients pose a particular challenge with respect to relaxation. They tend to be skeptical, to prefer strategies that allow them to remain in control, to be impatient and to have little power of self-observation (5, 9). Certainly it is true that relaxation may provoke anxiety and resistance (10). Many professionals involved in cardiac rehabilitation consider it useful for all patients to learn relaxation (5, 11), even though it may have appeal to a minority only. Others assume that only some patients need to learn it (12).

On the other hand, the rehabilitation period is suitable for learning more adequate coping styles. The most popular treatment form, aerobic conditioning, has only a modest psychic effect (1, 13, 14). The aforementioned cardiac patients provide the rationale for behavioral intervention such as relaxation to take place. Certainly, introducing relevant coping styles and motivating patients to utilize them poses a significant challenge to health professionals (9).

An adequate strategy depends as much on the relaxation procedure and technique as on the context of the rehabilitation setting. In St. Joannes de Deo Hospital, Haarlem, The Netherlands, a procedure for individual treatment was developed. It centered around respiration, also using EMG-feedback and general relaxation (15). A randomized controlled trial of this relaxation therapy showed that it improved the overall physical benefit of training, in comparison with only exercise training (16). In particular, the risk of a negative training outcome was diminished by 50% and ST-segment abnormalities, indicating myocardial ischemia, were significantly reduced. A two-year follow-up revealed that patients who learned to relax experienced significantly fewer cardiac events (17). With respect to the psychic benefit of rehabilitation, exercise per se did not result in any psychic change, but the combined treatment of exercise and relaxation increased perceived well-being and reduced anxiety and feelings of invalidity (18).

The nature of the procedure employed was breathing awareness. Most relaxation techniques do not address respiration directly, so as not to disturb its autonomic character by voluntary control. The rationale is, that when one relaxes physically and mentally, respiration becomes optimal. On the other hand, regulating (pacing) respiration modulates the stress response and anxiety (19, 20). Teaching diaphragmatic breathing is effective in reducing stress for various disorders (21-24).

Although reduced arousal certainly affects respiration (25), respiratory *habits* do not necessarily change with general relaxation (26). Simply paying attention to breathing without specific instruction can also disturb it, because of an over-consciousness or by evoking faulty or strenuous habits.

An underlying fact is the dual role of respiration as a voluntary and involuntary function. Breathing may be an indicator of tension but functions as well as a regulator of tension. The problem of breathing technique is how to use the latter potential without disturbing its feedback value as a tension indicator. Therefore, techniques derived from voice and breathing therapy were integrated in general relaxation technique, emphasizing body awareness and passive concentration. This resulted in "breathing awareness" as a relaxation method. Its aim is to elicit a shift in the respiratory pattern towards a more easy and natural pattern while avoiding strain and effortful practice. When successful, this has strong subjective effects and usually lowers respiration rate. This method was applied to cardiac patients, because, as was mentioned earlier, it is for cardiac patients of prime importance to achieve an experience of relaxation within the first sessions of relaxation therapy. A limited number of sessions should be sufficient as a first step to master the basic technique. It is of equal importance to emphasize sensory awareness and to notice bodily signals of tension and relaxation. The majority of the patients are not at all used to being aware of these signals, or on the contrary, to ignoring them. "Feeling well" means "feeling nothing," i.e., there is nothing to complain about. Finally, it is important to present relaxation as a psychologically neutral technique and as part of the normal rehabilitation program.

The questions to be answered are,

1) does relaxation, applied in the procedure outlined above, reduce respiration rate and increase body awareness,

2) do respiration rate and body awareness in turn induce beneficial effects with respect to the total rehabilitation outcome,

3) which respiratory parameters are influenced in particular? (fine grain-analysis)

Table 1. Baseline Clinical Data

Variable	Treatment A		Treatment B	
No. of cases	76		80	
Age (years)	55.4	(8.2)	55.7	(8.1)
Males	71	(93)	76	(95)
Working	50	(66)	51	(64)
Married/with Partner	69	(91)	74	(93)
Size of MI:				
unknown	4	(5)	4	(5)
small	20	(26)	27	(34)
medium	27	(36)	22	(27.5)
large	25	(33)	27	(34)
In-hospital signs of heart failure	14	(18)	13	(16)
Medication on discharge:				
beta blockers	20	(26)	25	(31)
diuretics	27	(36)	20	(25)
anti-anginal	13	(17)	18	(23)
Start of physical training (weeks after hospital dscharge)	4.8	(2.8)	5.2	(2.1)
Exercize testing:				
Maximum work load (watt)	136	(24)	132	(21)
ST-segment abnormalities	24	(32)	20	(25)
Angina pectoris	9	(12)	9	(11)

Data are reported as events and percentages of cases or as means (SD), MI, myocardial infarction.

PATIENTS AND METHODS

Patients

After being discharged from several hospitals, cardiac patients are referred to the regional rehabilitation center at St. Joannes de Deo Hospital, Haarlem, The Netherlands. In three intake periods (1981-1983), a total of 156 myocardial infarction patients were found eligible for the study. They were randomly allocated to two treatment protocols. Patients who were considered to need individual (psychosocial) help in addition to exercise training were excluded. There was no age limit. Table 1 summarizes the clinical data at the time of entry to the trial for the two randomized groups.

Treatment Programs

Rehabilitation consisted of a program of relaxation training in addition to exercise training (Treatment A) or of exercise training only (Treatment B). The exercise training consisted of 5 weeks of interval training, once a day for half an hour, on a bicycle ergometer. Training was done in groups of four patients supervised by two physical therapists. Each patient exercised up to 70% of the maximal heart rate attained at the pre-training exercise test.

Relaxation training was given once a week in six individual sessions of one hour, by five specially trained persons. Three of them were a psychologist, a medical doctor and a physical therapist. Several procedures for active and passive relaxation were employed: EMG feedback of the frontalis muscle was used , 1) as a "mental device" (25) to focus attention for passive relaxation, 2) to give feedback of muscle tension and explain the concept of relaxation, 3) to monitor excess inspiratory effort.

For breathing instruction, attention was directed to respiratory movement (rate, depth, location, ease, regularity). In the supine position, one hand was placed on the lower abdomen, accompanied by the words, "the hand notices what the body does." Next, a technique to influence respiration was applied. Audible lip breathing is an example of this method. It is postulated that this technique stimulates inspiration and diaphragmatic activity, while preventing strain in the throat or chest. Then, attention was again directed towards passively monitoring breathing and the patient was asked to compare the result with the previous condition. The point was made that the primary aim of the technique is to become aware of differences, first in quality of respiratory movement, next in body sensation, and finally in thought, mood and feeling.

The patient learned to observe and elicit a "shift" towards a more easy, free and effortless respiratory pattern, with a smooth rhythm of inhalation and exhalation. The therapist monitored respiration and gave feedback so that inspiration expanded both the lower abdomen and the costal margin. Expiration was moderate and slow. Manual techniques were applied to elicit breathing movements which involved the trunk as a whole and required less effort. This was practiced first in the supine, relaxed position, but later also as the subject was sitting and standing ("active relaxation"). The patient was then asked to practice at home and also when experiencing chest discomfort.

Care was taken to introduce relaxation as a part of the routine rehabilitation procedure and not a means of providing special psychological help. The treatment itself was presented in a neutral fashion. It emphasized the technical and physical aspects of relaxation and its utility in dealing with daily challenges. Also provided was a rationale, in the form of the biofeedback instrumentation, for incorporating the treatment. Finally, breathing "exercises," and the masking of psychological implications also made up the rehabilitation treatment.

Measurements

An appointment was made for the physiological test, at which occasion psychological questionnaires were also completed. All patients performed the graded exercise test at the beginning of the physical training. Both tests were repeated after rehabilitation; the physiological test was also repeated three months later.

Psychological Questionnaires

Before and after rehabilitation the patients completed a set of four psychological questionnaires. They were as follows: first, the Heart Patients Psychological Questionnaire (HPPQ), constructed to measure the well-being of cardiac patients (27), consists of the scales: Well-being (HPPQ-W), Subjective Invalidity (HPPQ-I), Displeasure (HPPQ-D), and Social Inhibition (HPPQ-S). The second type of psychological questionnaire was the STAI, measuring: state and trait anxiety (28). Sleep Quality, measured with a 10-item questionnaire was the third (29). Functional Complaints, a 25-item questionnaire constructed to measure complaints often mentioned by cardiac patients but not typical of angina pectoris was the final form.

Exercise Testing

All patients performed on a bicycle ergometer (Monark) before and after the physical training. The test started with a one-minute period of cycling at 60 cycles a minute without load, then for two minutes at 60 Watts. The test was continued by increasing the workload with 30 Watts every two minutes until symptoms limited the patient to continue or until the physician terminated the test. Exercise-induced signs of cardiac dysfunction (ST-abnormalities, angina pectoris, serious dysrhythmias) were noted and heart rate and systolic blood pressure were measured.

Physiological Test

The test was introduced to the patient as a physiological measurement of the resting condition, in addition to the exercise test which measured the condition during effort. The research assistant was blind to the treatment form of the patient. He did not refer to the relaxation therapy and took care not to make any suggestions with regard to "proper" breathing.

Protocol: after attaching the equipment, the patient remained standing for two minutes. Measurements during the second minute ("standing") were used, after which time the patient was to lie down on the back. Measurements in the second minute of lying down were used ("supine"). Next, the use of mouthpiece and nose-clip was explained and they were attached. After this, the patient was to lie quietly without making physical movements or talking. This lasted six minutes. Measurements in the first ("mouthpiece") and last minute ("quiet") were used.

Body awareness: at the end of the test the patient's self assessment, specifically perceptions concerning the body's state, were recorded. Answers were rated as 1 = pleasant, 2 = no particular feeling, 3 = unpleasant.

Respiration: respiratory movements and heart rate were continuously recorded polygraphically with a Psychophysiograph (ZAK). One band was strapped around the chest at the level of the fifth intercostal space, and one around the abdomen at the umbilical level, both bands containing a transducer which provided stretch dependent voltage changes. This was converted into a recording of chest and abdominal expansion and retraction. Respiration rate per minute was calculated.

Respiratory sinus arrhythmia: a finger plethysmograph was used to measure the pulse, converted by a cardiotachometer in a beat-to-beat recording of heart rate, simultaneous with respiration. Respiratory sinus arrhythnmia was calculated as the mean difference between minimum beat interval during inspiration and maximum interval during expiration for five consecutive respiratory cycles.

Ventilation: using a mouthpiece and nose-clip, air was sampled from the mouthpiece and carbon-dioxide concentration (% volume) was measured with a capnograph (Jaeger). End-tidal carbon-dioxide concentration in the exhaled air was used. Ventilation was measured with a wet spirometer (Lode). Tidal volume registrations corresponded with the amplitude of the simultaneous polygraphic recording of rib-cage and abdominal motion. On the basis of this, tidal volume at the beginning (supine) and the end of the text (quiet) was estimated, and minute volume was calculated.

Method of Analysis

For statistical testing: Student's t-test was used for measurements of a metric level and chi square for measurements of a nominal level. It then followed that the measurements, obtained through exercise testing pre and post training, were integrated into a composite criterion for "training benefit" (TB), trichotomized as follows: a. the patients with doubtful or no change (TB=O), b. the patients who improved (TB=+) or c. the patients who deteriorated (TB=-). The procedure is described in detail elsewhere (16). In short, the measurements were ranked into four levels according to their clinical relevance: 1) signs of cardiac dysfunction, 2) maximum work load, 3) maximum heart rate, and 4) systolic blood pressure response. At each level a patient could be selected for TB=+ or TB=- when a significant change in the particular measurement had occurred. Finally, dropouts were included and classified on the basis of the reason for not completing the program.

The next portion of the evaluation involved psychic outcome. In this report psychic outcome is distinguished in 1) well-being, measured by HPPQ-W; 2) psychic function measured by STAI-S, STAI-T and HPPQ-D, representing anxiety and depression; and 3) somatic function measured by HPPQ-I, sleep quality and functional complaints. For psychic and somatic function, the scores on the questionnaires were standardized and summed-up and the resulting scores were dichotomized in favorable and unfavorable changes.

RESULTS

There were no differences between the two treatments in base-line clinical data as shown in Table 1. Infarction size, classified on the basis of the peak serum enzyme levels, was small in 47 patients, medium in 49 patients and large in 52 patients. In-hospital signs of heart failure occurred in 27 patients (17%). On the average, patients visited the rehabilitation centre during the third week after hospital discharge and underwent initial exercise testing two to three weeks later. Most patients (93%) reached a maximum work load of at least 120 Watts, with an average of 133 Watts, or 89% of the exercise tolerance predicted on the basis of age, gender and height. Forty-five patients (29%) were on beta-blocking medication.

Relaxation Effect

Table 2 shows that average respiration rate, prior to rehabilitation, was about 15/minute and did not differ between treatments. At post-test and at follow-up it decreased to 12.5/minute for Treatment A but was unchanged for Treatment B. The differences were significant ($p < 0.0001$). Figures 1 and 2 show that during the test, respiration rate declined from 17/minute (standing) to 16/minute (lying down) to 13/minute after breathing through a mouthpiece and went back to 14/minute (quiet).

Table 2. Effect of Relaxation Training on Respiration Rate

Average respiration rate	Treatment A n	Treatment A $\bar{x}$	Treatment A (SD)	Treatment B n	Treatment B x	Treatment B (SD)	p*
pre-test	73	14.7	(3.7)	7	15.2	(3.6)	ns
post-test	66	12.5	(3.7)	70	15.0	(3.2)	< 0.0001
pre-post difference	65	2.1	(2.8)	69	0.2	(1.9)	< 0.0001
three months follow-up	67	12.6	(3.8)	67	15.2	(3.5)	< 0.0001
pre-follow-up difference	66	1.9	(3.0)	66	-0.1	(2.4)	< 0.0001

* Difference between treatments: Student's t-test, two-tailed

This pattern of a steady decline and a slight increase at the end of the test did not change after rehabilitation. For Treatment A, however, after rehabilitation, all values became substantially lower. The difference with Treatment B was highly significant for all measurements at post-test and at three months follow-up. This means that relaxation induced a stable, more quiet respiratory pattern.

Results of the study also involved the following findings. Before rehabilitation the majority of the patients (Treatment A: 63%, Treatment B: 65%) did not notice anything in particular when asked at the end of the test how they felt their body to be (see Table 3). A small number (Treatment A: 10%, Treatment B: 7%) had unpleasant sensations. After rehabilitation most patients in Treatment A (60%) had a pleasant sensation; this change is significant ($p < 0.001$). Patients in Treatment B felt no change. The difference between the treatments in the post-test situation was significant ($p < 0.01$) and also at follow-up ($p < 0.005$). It means that as a result of

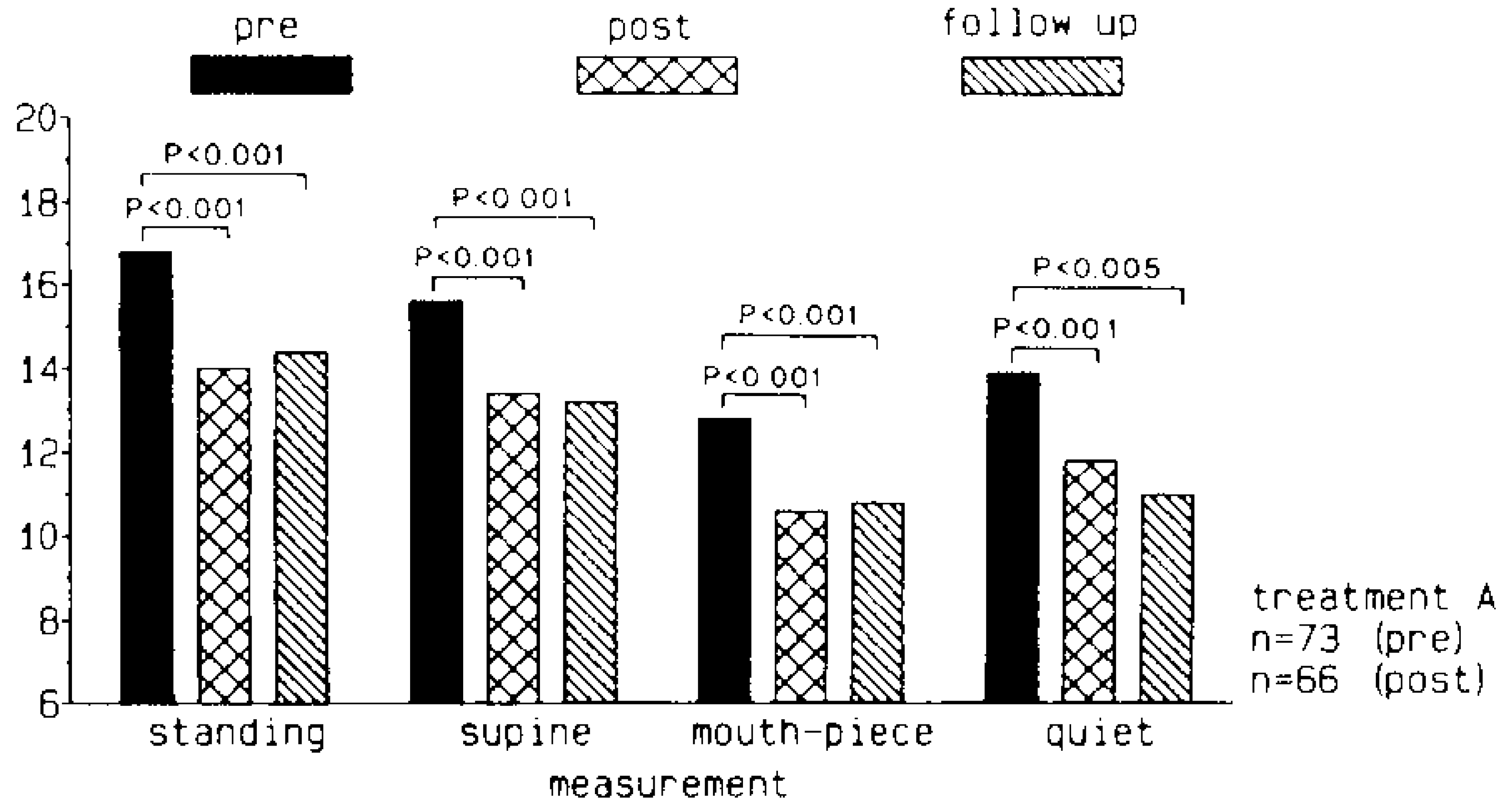

Figure 1. Respiration rate pre-test, post-test and at follow-up for Treatment A.

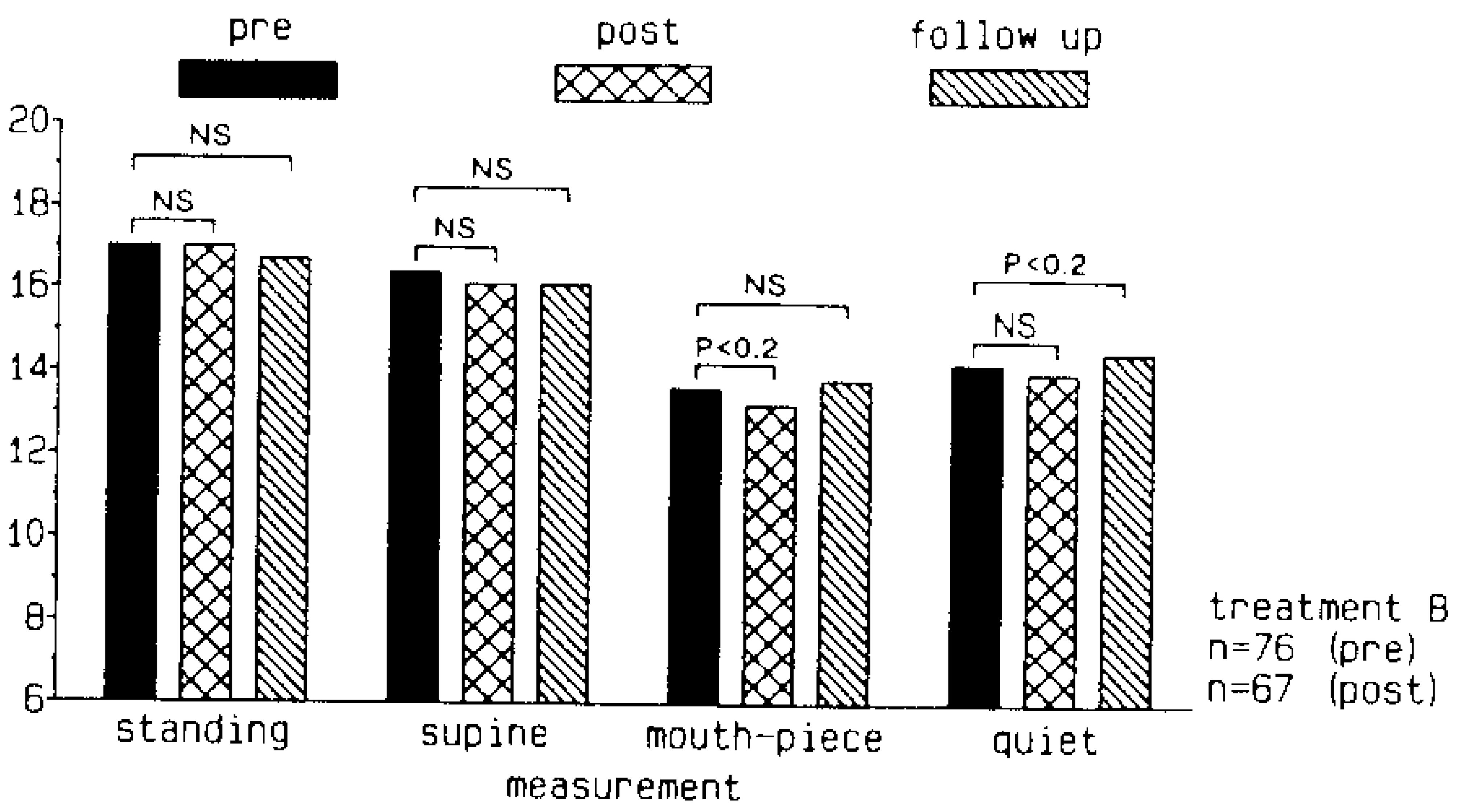

Figure 2. Respiration rate pre-test, post-test and at follow-up for Treatment B.

relaxation training, body awareness increased and physical rest induced more pleasurable body sensations.

Relation of Rehabilitation Outcome To Respiration Rate and *Body Awareness*

The testing procedures produced several outcomes of a significant physical nature. First of all, the composite criterion of training benefit indicated that in Treatment A, 42 patients (55%) improved physically after rehabilitation and 37 patients in Treatment B (46%). Patients were considered not improved when they did not change (Treatment A: 25%,Treatment B: 21%) or deteriorated after training

Table 3 Effect of Relaxation Training on Body Awareness

Body sensation after rest	Treatment A n(%)	Treatment B n (%)	p*
pre-test			
pleasant	16(27)	17(28)	
nothing particular	37(63)	39(65)	
unpleasant	6(10)	4 (7)	ns
post-test			
pleasant	38(60)	23(33)	
nothing particular	20(32)	38(55)	
unpleasant	5 (8)	8(12)	< 0.01
three month follow-up			
pleasant	38(59)	18(28)	
nothing particular	20(31)	39(60)	
unpleasant	6 (9)	8(12)	< 0.005

*Difference between treatment: chi square, df=2, two-tailed

(Treatment A 20%, Treatment B: 33%). Table 4 shows that for both treatments the respiration rate at post-testing was slightly higher with patients who improved physically, in comparison to patients who did not improve. The difference was not significant. Thus, respiratory rate was not related to physical benefit. Positive body awareness had no relation to training benefit either.

The most significant finding related to the psychic nature of the individual was that most patients in Treatment A improved in perceived well-being (HPPQ-W). Those who improved were breathing slower than those who did not improve ($p < 0.05$). Body awareness, however, was only slightly more positive. In Treatment B, well-being only slightly improved after rehabilitation. There was no relationship between improvement and respiration rate or body awareness post-testing.

Importantly, the psychic function (anxiety and depression) showed a positive change in most patients (Treatment A: 69%, Treatment B: 70%). For Treatment A improvement of psychic function had no relation to either respiration rate or body awareness. In Treatment B, patients who improved psychically were breathing faster at post-testing ($p < 0.05$). They did not differ in body awareness from patients who did not improve. Also, the patients' somatic function (sleep quality, feelings of invalidity and functional complaints) showed a positive change (Treatment A: 69%, Treatment B: 60%). Patients in Treatment A who improved somatically tended to breathe slower at post-testing ($p < 0.20$) and had significantly more positive body awareness ($p < 0.02$). This means that somatic improvement was related to the relaxation effect. In Treatment B, patients who improved somatically were breathing slightly faster.

Respiratory Changes: Fine Grain Analysis

Data collected with the physiological test were analyzed for a sub-set of the patients admitted to the study in 1982. Out of 58 patients, post-test measurements were available for 48 (Treatment A: 24, Treatment B: 24).

Estimated tidal volume at the beginning of the test increased for Treatment A from 0.61L to 0.69L (see Figure 3). It decrease in Treatment B from 0.59L to 0.5L ($p < 0.05$). The difference between the treatments was significant ($p < 0.05$). At the end of the test, tidal volume was smaller than at the beginning, particularly for Treatment B, both before and after rehabilitation.

Also, estimated minute volume was 8.0L for Treatment A and 8.5L for Treatment B at the beginning of the test (see Figure 4). It increased slightly for Treatment A and decreased a little for Treatment B after rehabilitation, but not significantly. During the test, minute volume decreased substantially, both before and after rehabilitation, irrespective of the treatment. This means that physical rest clearly reduced ventilation.

Yet another important observation involved estimated effective ventilation. It was calculated as tidal volume minus 0.15L (the average volume of dead air space) times respiration rate. Again, for Treatment A effective ventilation increased (from 5.9L to 6.3L), whereas it decreased for Treatment B (from 6.2L to 5.5L). The difference between treatments was not significant.

Furthermore, end-tidal CO2 concentration increased significantly in Treatment A from 4.3 (0.5) vol% to 4.5 (0.5) vol% after training ($p < 0.05$). In Treatment B it increased slightly from 4.5 (0.6) vol% to 4.6 (0.6) vol%. The difference between treatments was not significant.

Table 4. Four Outcome Measures, Related to Respiration rate and Body Sensation, for Treatment A and Treatment B.

	Respiration rate at post-test							
	Treatment A				Treatment B			
	n			p*	n			p*
Exercise testing								
improved	38	12.7	(3.6)		35	15.4	(3.1)	
not improved	28	12.1	(3.8)	ns	35	14.6	(3.3)	ns
Well-being								
improved	48	11.8	(3.3)		39	15.1	(2.9)	
not improved	18	14.1	(4.2)	0.03	30	15.1	(3.5)	ns
Psychic function								
improved	43	12.2	(3.6)		46	15.4	(3.1)	
not improved	19	12.4	(3.5)	ns	20	14.0	(2.5)	0.05
Somatic function								
improved	41	11.9	(3.7)		38	15.4	(3.2)	
not improved	20	13.3	(3.2)	0.1	26	14.4	(3.4)	ns

	Body sense at post-test (**)							
	Treatment A				Treatment B			
	n			p*	n			p*
Exercise testing								
improved	36	1.5	(0.7)		35	1.8	(0.6)	
not improved	27	1.5	(0.6)	ns	34	1.8	(0.7)	ns
Well-being								
improved	47	1.4	(0.6)		38	1.8	(0.6)	
not improved	16	1.6	(0.8)	ns	31	1.7	(0.6)	ns
Psychic function								
improved	41	1.4	(0.6)		46	1.8	(0.6)	
not improved	18	1.5	(0.7)	ns	20	1.7	(0.7)	ns
Somatic function								
improved	40	1.4	(0.5)		38	1.8	(0.6)	
not improved	18	1.8	(0.9)	0.02	25	1.8	(0.7)	ns

*Student's t-test, two-tailed;
**1 = pleasant, 2 = nothing particular, 3 = unpleasant

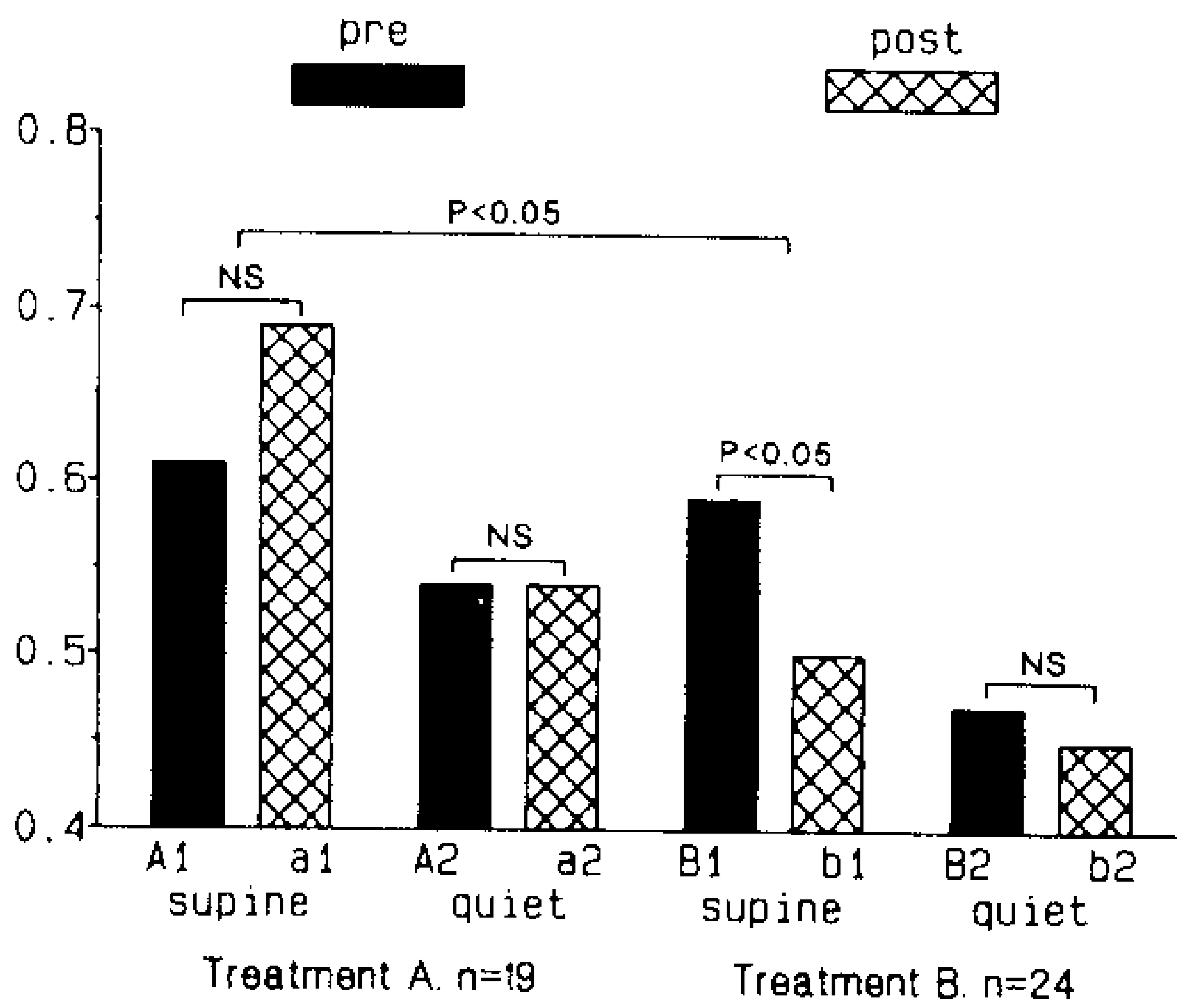

Figure 3. Estimated tidal volume pre-test and post-test for Treatment A and B.

Chest and abdominal motion was also significant. The relative contributions of rib-cage and abdomen to the respiratory movement could be tentatively estimated as being the ratio of the amplitude of the abdominal and rib-cage recording. This ratio was 4.2 for Treatment A and 4.6 for Treatment B at the beginning of the pre-test. During the test it increased for both treatments to 4.5 and 5.0 respectively. This means that abdominal contribution to respiration increased relatively during the test. After training the ratio increased during the test from 5.3 to 5.8 in Treatment A, and in Treatment B from 3.4 to 4.2. Consequently, abdominal breathing had increased in Treatment A but had diminished in Treatment B. The difference between treatments was not significant ($p = 0.14$).

Finally, respiratory sinus arrhythmia was observed (Figure 5). The heart rate variability during slow breathing (6 cycles/minute) both at the beginning and at the end of the test increased for Treatment A after training ($p < 0.005$ respectively $p < 0.02$). For Treatment B respiratory arrhythmia did not change. The difference between treatments was more pronounced at the end of the test ($p < 0.05$) than at the

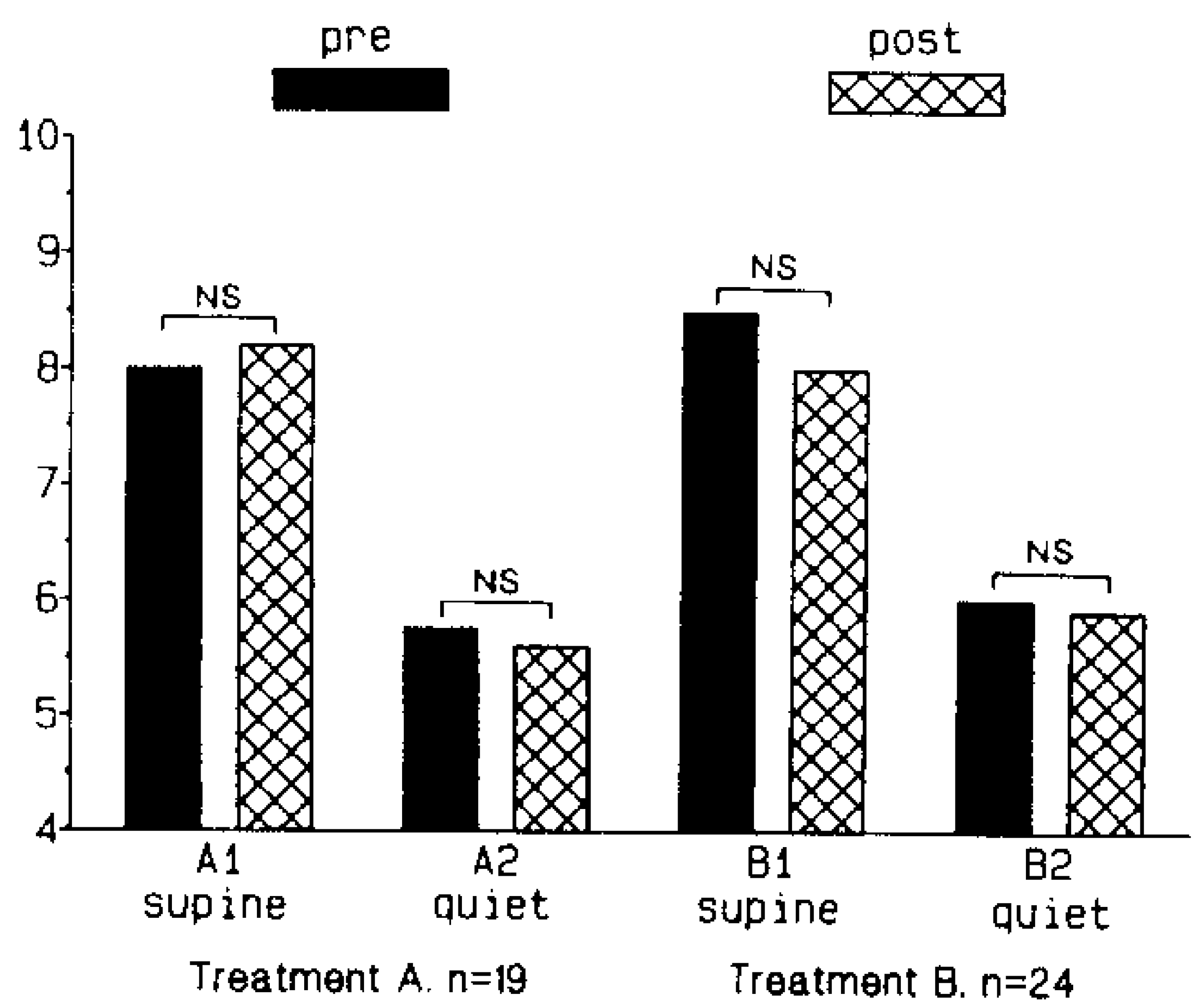

Figure 4. Estimated minute volume pre-test and post-test for Treatment A and B.

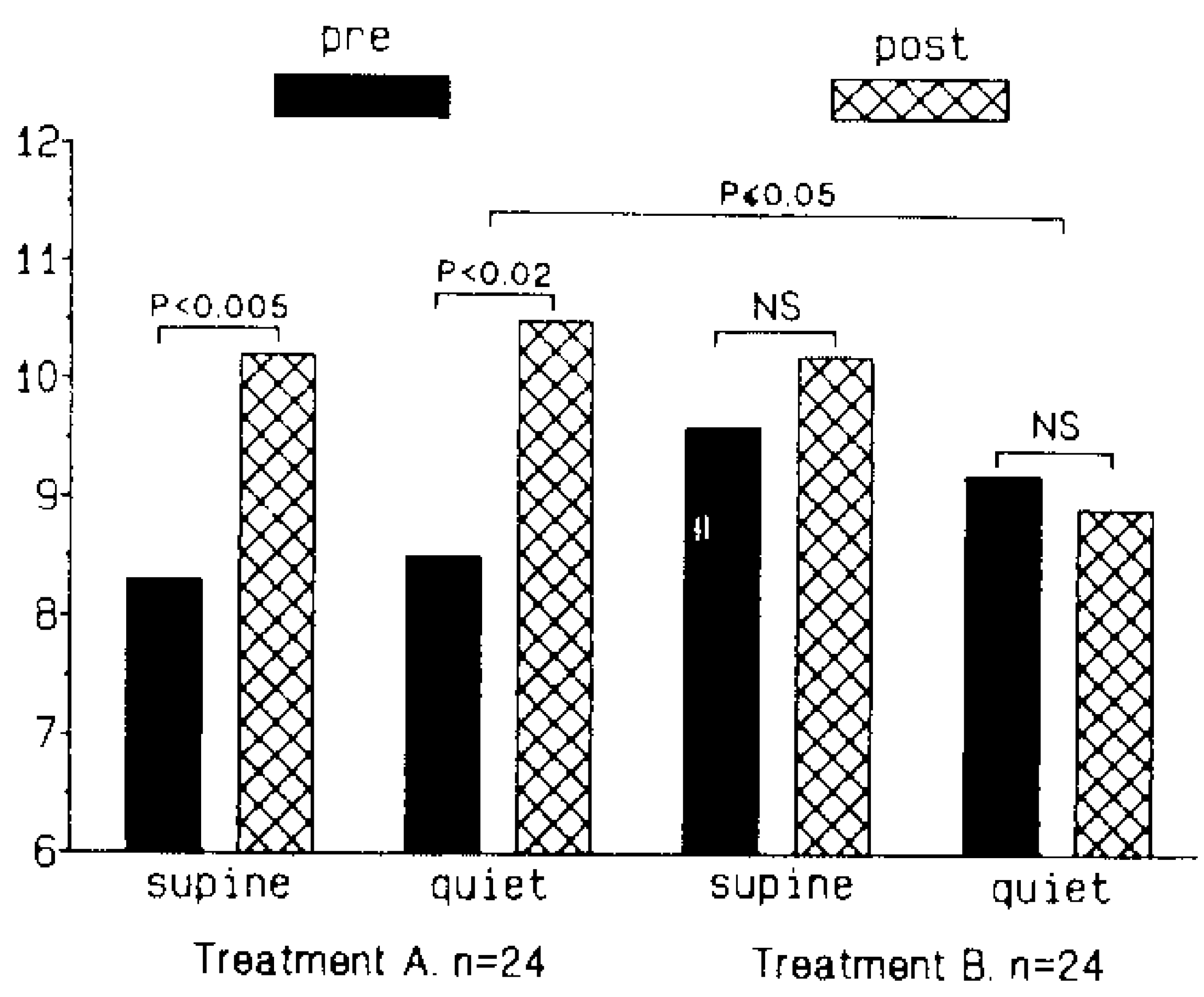

Figure 5. Respiratory sinus arrhythmia pre-test and post-test for Treatment A and B.

beginning ($p = 0.10$). Average variability differed significantly between treatments ($p < 0.04$).

DISCUSSION

Effect on respiration: This study showed that breathing awareness as a relaxation method has been successful in calming respiration and inducing positive body awareness for myocardial infarction patients. Regarding the implications of this result, several points need to be considered. First, the exploratory fine grain analysis on a sub-set of patients showed that a slower respiration rate meant that ventilation became more efficient, because tidal volume increased while minute volume remained practically unchanged. Thus, the proportion of inhaled air used for gas exchange increased, as well as the time for oxygen exchange in the lungs. The increased effective ventilation did *not* result in excess ventilation (hyperventilation), which would have been a negative side-effect (30, 31). In fact, the number of patients with CO2 below 4.0 vol% dropped from 3 to 1 in Treatment A, whereas it rose from 4 to 6 in Treatment B.

Second, it was found that physical training did not improve respiration. The fine grain analysis showed that patients in Treatment B even tended to breathe more superficially after training. For both treatments, patients with physical training benefit did not breath slower. Thus, contrary to expectation (32), respiration was not inherent to a physical training effect.

Third, the decrease in respiration rate, although highly significant, was modest. When patients are taught to breathe diaphragmatically and asked to perform their skill, respiration frequencies of 4-8/minute would not have been surprising (20,21). In the approach utilized in this study, however, emphasis was less on voluntary skill and more on a shift in the spontaneous respiration pattern. The idea was that a change in the habitual pattern would be more durable. The stability of the results at the three month follow-up confirmed this. The finding has been confirmed even after two years: in 38 patients a registration of respiration was carried out at the follow-up interview Figure 6 shows that respiration rate was still lower for Treatment A, whereas Treatment B showed an unchanged frequency. The difference was highly significant.

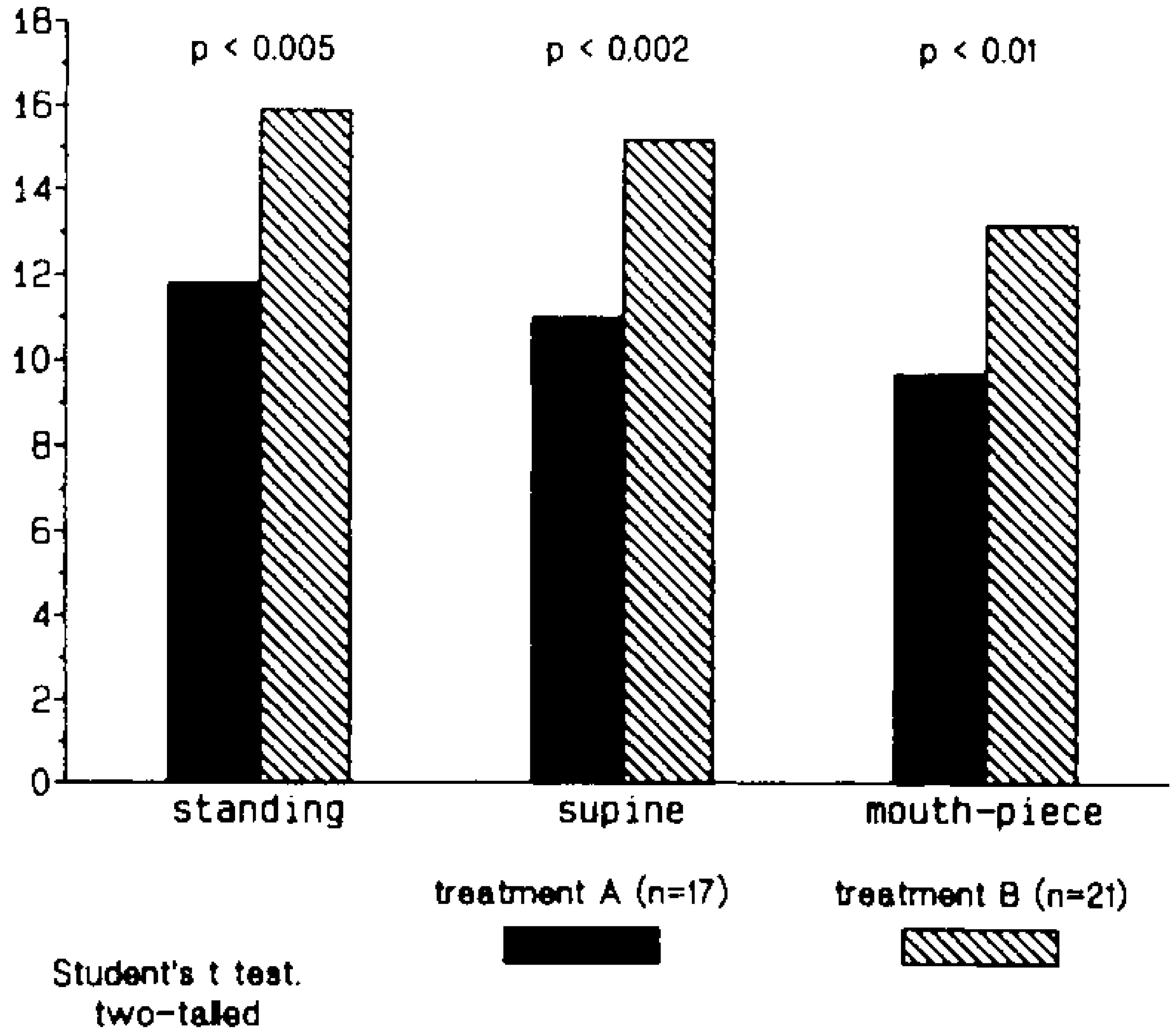

Figure 6. Respiration rate at two year follow-up for Treatment A and B.

Fourth, the study indicated that reducing respiration rate is not an ideal to be achieved. Rather, the express purpose should be to induce a psychophysiological change and to retain the connection of respiration to other physiological and psychological variables (33). The procedure of breathing awareness seemed to have been successful in that respect, because the response of respiration rate to the various phases of the physiological testing (standing, lying down, mouthpiece breathing, quiet) remained unchanged. This means that respiration became more quiet through breathing therapy but was not forcefully controlled and remained a valid tension indicator. Also, respiratory change was not limited to frequency, but included other parameters, e.g., sinus arrhythmia.

However, the interrelation of frequency with other respiratory variables deserves further study, in order to characterize possible changes in respiratory pattern in more detail. For instance, prior to rehabilitation, respiration frequency did not correlate with carbon dioxide. Only after breathing therapy was the expected negative correlation found. This means that breathing awareness strengthened the interrelation of respiratory parameters.

Also, although the relaxing effect of breathing technique is often ascribed to increasing diaphragmatic activity and decreasing upper-thoracic breathing, this seems to be an overly simplistic conclusion. The coordination of the diaphragm with respiratory muscles in the abdomen, the back and in the chest is more important than diaphragmatic strength (34-36). For instance, there was no tendency for upper-thoracic breathing among the cardiac patients (37). Instead, the rib-cage contributed far less to respiratory movement than the abdomen. This tendency was strengthened by the relaxation method, which put emphasis on breathing movement in the lower abdomen. This finding seems paradoxical, considering that efficient breathing involves movement of the whole trunk, including the pelvis, spine and breast-bone (38). It was noted however, that the rib-cage showed small amplitudes, because the chest was rather stiff and usually was wide. In the supine position on the back it became even more fixed. Thus, the absence of gross upper-thoracic breathing did not imply an adequate costo-abdominal rhythm. For that reason, manual techniques were used in various postures to improve the rhythmic expansion and contraction of the whole body under respiration. The technique for home practice started with natural breathing in the lower body, because focusing attention on the chest has a risk of evoking forceful breathing.

Finally, the method employed focused on sensory discrimination of differences in breathing pattern and in bodily tension. The "exercise" was to compare the condition before and after a particular procedure, and to become aware of the difference. Thus, the relatively strong impact of respiratory change was coupled to "passive" awareness and self-observation. It seems that the ability for sensory awareness is the core of all relaxation procedures. The problem was how to introduce this concept to cardiac patients and whether they could tolerate increased sensitivity to inner physical events. When successful, this awareness has the psychological function to reduce anxiety, in particular about the body. Obviously, it is necessary to master the techniques of breathing and relaxation, eventually integrating them into the emotional state.

The outcome of the present study indicated that body awareness had indeed been increased. It should be noted, however, that this concerned a pleasurable experience occurring at the end of the test, i.e., after about 15 minutes. It means that physical rest had become more of a positive experience. Probably a more favorable attitude toward relaxation was induced, rather than the more negative interpretation of the need for physical rest as a sign of weakness. In fact, patients in Treatment A continued taking daytime rests, whereas patients in Treatment B rested less often after rehabilitation. At the two-year follow-up, the treatments still differed in this respect.

The following contentions are therefore justified: that the method of breathing awareness 1) has been effective in changing the habitual respiratory pattern; 2) proved to be a valuable instrument to introduce body awareness and also relaxation.

Two significant factors led to this outcome. First, focusing on breathing "activity," in addition to the feedback signals, made it easier to continue lying down for some time and being passive (25). In case a patient became more restless during passive relaxation (10) the treatment continued with active relaxation, either sitting or standing. Second, the respiratory pattern which resulted from the breathing technique, together with reduced muscle tone (39) induced a "drowsy" state of mind (40,41), which facilitated passive awareness. Practical experience with this procedure showed that it was acceptable to the patients: no one stopped relaxation therapy. After the study, the relaxation procedure was retained as an individual treatment in the rehabilitation. Also, all patients now have one group relaxation session and it is incorporated in the regular physical exercise. In this way, most patients appear to be positive about relaxation.

The rehabilitation outcome can be summarized as follows. Relaxation therapy appeared to improve rehabilitation outcome, as well as respiration and body awareness. The question remains whether the latter effect is instrumental for bringing about an effect on rehabilitation outcome. However, the improvement in patient well-being was clearly related to slower respiration for Treatment A. The effect of relaxation on well-being may therefore be interpreted as partially the result of its influence on respiratory pattern. Improvement in somatic function was related to positive body awareness for patients who learned to relax; they also showed a trend towards slower breathing. Relaxation may have enabled these patients to experience and view their bodies differently, placing different limitations on physical potential. Furthermore, patients in Treatment B improved almost to the same degree, but without concomitant increase in body awareness. Possibly, recovery may have been a different process for them. If that thought is correct, it means that relaxation modifies the influence of rehabilitation on recovery. Another indication for this reality involved the inverse relation between respiration and psychic improvement for Treatment B. A possible interpretation is that, for those patients, heightened activity served as a way to cope with anxiety and depression (42). A kind of masking effect allowed patients to deal with depression.

It is possible that relaxation influences the way in which the patient experiences the rehabilitation, and what he learns from it. There is an enhanced ability to reflect upon lifestyle. The psychological literature on cardiac patients mentions an inability to relax; a preference for activity and resistance to passivity; a need for control and a firm belief in active, effortful coping strategies; a tendency to deny problems and minimize complaints. Cardiac rehabilitation usually addresses these tendencies by focusing on proper aerobic conditioning. The value of breathing and relaxation technique seems to be that it facilitates the ability for the individual to change, and to make rehabilitation more of a learning experience.

Future research is necessary to distinguish patients who were able to learn relaxation from those who could not master the techniques. Inability to relax and to breathe quietly may result from physical handicaps, e.g., intolerance for increased body sensitivity. Also, the motivation of the patient and the relation with the therapist are of importance. An intriguing question involves the degree to which a successful rehabilitation outcome depends upon a potential ability to relax.

SUMMARY

A relaxation method emphasizing sensory awareness and relaxed, diaphragmatic breathing, was introduced into a cardiac rehabilitation program. As compared to a physical exercise program, this method effectively reduced respiration rate and increased pleasant body sensations during physical rest. Simultaneously, ventilatory efficiency increased, hyperventilation was reduced, and heart rate variability increased.

After rehabilitation, slower respiration was associated with a higher level of perceived well-being, whereas positive body awareness signified more adequate psychosomatic function (sleep quality, functional complaints, sense of invalidity). Patients who learned to relax retained the habit of taking a siesta. At the time of a two-year follow-up, respiration rate still persisted to be lower and siesta time was longer than in patients who followed exercise training only.

It is concluded that the method of breathing awareness is suitable to induce relaxation and body awareness for cardiac patients.

REFERENCES

1. Stern, M., Gorman,P. and Kaslow,L. 1983. The group counseling vs exercise therapy study. *Arch. Int. Med.* 143: 1719.

2. Langosch, W., Seer,P., Brodner, G., Kallinke, D., Kulick, B. and Heim,F. 1982. Behavior therapy with coronary heart disease patients: results of a comparative study. *J Psychosom. Res.* 26: 475.

3. Polackova, J., Bockova,E. and Sedivec,V. 1982. Autogenic training: application in secondary prevention of myocardial infarction. *Activ. Nerv. Sup.* 24-3: 178.

4. Krampen, G., and Ohm,D. 1984. Effects of relaxation training during rehabilitation of myocardial infarction patients. *Int. J. Res.* 7-1: 68.

5. Ohm, D. 1987. Entspannungstraining und Hypnose bei Patienten mit koronaren Herzkrankheit in der stationaren Rehabilitation. Roderer Verlag, Ragensburg.

6. Suinn, R. 1974. Behavior therapy for cardiac patients. *Beh. Ther.* 5: 569.

7. Friedman, M., Thoresen,C., Gill, J., Ulmer, D., Thompson, L., Powell, L., Price, V., Elek, S., Rabin, D., Breall, W. Piaget,G., Dixon, T., Bourg, E., Levy, E. and Tasto,D. 1982. Feasibility of altering Type A behavior pattern after myocardial infarction. *Circulation.* 66-1: 83.

8. Dixhoorn, J. van, Bar, F. W. H., Erdman, R.A.M., Keulen, A.M.A. van. 1988. Cijfers en beschouwingen over poliklinische hartrevalidatie: een inventarisatie. *Hart Bull.* 19:11.

9. Sime, W.E. 1980. Emotional stress testing and relaxation in cardiac rehabilitation. *In*: "Stress and tension control," McGuigan, F.J., Sime, W.E., and Wallace, L. Macdonald, eds., Plenlum, New York.

10. Heide, F., and Borkovec,T. 1984. Relaxation-induced anxiety: mechanisms and theoretical implications. *Behav. Res. Ther.* 22-1: 1.

11. Hackett, T.P., and .Cassem,N.H. 1982. Coping with cardiac disease. *In*: "Comprehensive cardiac rehabilitation," Kellerman, J.J., ed., Karger, Basel.

12. Fardy, P. 1986. Cardiac rehabilitation for the outpatient: a hospital-based program. *In*: M.L.Pollock, D.H.Schmidt, D.T., ed. Heart Disease and Rehabilitation. Wiley, New York, 1986. Mason

13. Mayou, M. 1983. A controlled trial of early rehabilitation after myocardial infarction. *J. Cariop. Rehab.* 3: 397.

14. Hughes, J. 1984. Psychological effects of habitual aerobic exercise: a critical review. *Prev. Med.* 13: 66.

15. Van Dixhoorn, J. 1984. Body Awareness: the proper application of relaxation and breathing technique. *Gedrag.* 12: 31.

16. Van Dixhoorn, J., Duivenvoorden, H.J., Staal,H.A. Pool,J. and F. Verhage. 1988. Physical effects of exercise training and relaxation therapy in cardiac rehabilitation, assessed through a composite criterion for training outcome. Submitted.

17. Van Dixhoorn, J., Duivenvoorden, H.J., Staal,H.A., Pool, J. and Verhage,F. 1987. Cardiac events after myocardial infarction: possible effect of relaxation therapy. *Eur. Heart J.* 8: 1210.

18. Van Dixhoorn, J., De Loos,J. and Duivenvoorden, H. J. 1983. Contribution of relaxation technique training to the rehabilitation of myocardial infarction patients. *Psychother. Psychosom.* 40: 137.

19. Cappo,B.R., and Holmes,S.S. 1984. The utility of prolonged respiratory exhalation for reducing physiological and psychological arousal in non-threatening and threatening situations. *J Psychosom. Res.* 28-4: 265.

20. McCaul, K.D., Soloman,S. and Holmes,D.S. 1979. Effects of paced respiration and expectations on physiological and psychological responses to threat. *J Pers. Soc. Psych.* 37-4: 564.

21. Peper, E., Smith,K. and Waddell,D. 1987. Voluntary wheezing versus diaphragmatic breathing with inhalation (Voldyne) feedback: a clinical intervention in the treatment of asthma. *Clin. Biofeedback and Health.* 10-2: 83.

22. Grewal, J., Tan,W. and Sim,M. 1987. Evaluation of a diaphragmatic breathing exercise program for COPD patients. *Clin. Biofeedback and Health.* 10-2: 98.

23. Nagarathna, R., and Nagendra,H. 1985. Yoga for bronchial asthma: a controlled study. *Brit. Med. J.* 291: 1077.

24. Reybrouck, T., Wertelaers, A., Bertrand, P. and Demedts,M. 1987. Myofeedback training of the respiratory muscles in patients with chronic obstructive pulmonary disease. *J. Cardiop. rehab.* 7: 18.

25. Benson, H., Beary,J.F. and Carol,M. 1974. The relaxation response. *Psychiatry.* 37: 37.

26. Lum, L. C. 1976. The syndrome of chronic habitual hyperventilation. *In*: "Modern trends in psychosomatic medicine," Hill, O., ed., Butterworths, London.

27. Erdman, R. A. M. 1981. Welbevinden bij hartpatientedn. Swets & Zeitlinger, Lisse.

28. Van Der Ploeg, H., Defares,P. and Spielberger, C. 1980. Manual for the State-Trait Anxiety Inventory-DY. Swets & Zeitlinger, Lisse.

29. Visser, P., Hofman,W.F. and Kumar, .A. 1979. Sleep and mood: measuring the sleep quality. *In*: "Sleep research," Priest, R. G., Pletscher, A., and Ward, J., eds., MTP Press, Lancaster.

30. Neill, W.A., and Hattenhauer, .M. 1975. Impairment of myocardial 02 supply due to hyperventilation. *Circulation.* 52: 854.

31. Nixon, P.G.F., Al-Abbasi,A.H., King,J. and Freeman, L.J. 1986. Hyperventilation in cardiac rehabilitation. *Hol. Med.* 1: 5.

32. Astrand, P., and Rodahl, K. 1987. Textbook of work physiology. McGraw Hill, New York.

33. Grossman, P. 1983. Respiration, stress and cardiovascular function. *Psychophys.* 20-3: 284.

34. Kapandji, I. A. 1974. The physiology of the joints, III. Churchill Livingstone, London.

35. Parow, J. 1972. Funktionelle Atmungstherapie. Georg Thiem, Stuttgart.

36. Decramer, M., and Macklem, P. 1985. Action of inspiratory muscles and its modification with hyperinflation. *Airways.* 4: 19.

37. Hymes, A., and Nuernberger, P. 1980. Breathing patterns found in heart attack patients. *Res. Bull. Himal. Inst.* 2-2: 10.

38. Balfoort, B., and Van Dixhoorn, J. 1979. Ademen wij vanzelf? Bosch en Keuning, Baarn.

39. Gellhorn, E. 1958. The physiological basis of neuromuscular relaxation. *Arch. Int. Med.* 102: 392.

40. Timmons, B., Salamy,J., Kamiya, J. and Girton, D. 1972. Abdominal-thoracic respiratory movements and levels of arousal. *Psychon. Sci.* 27: 173.

41. Naifeh, K.H., and Kamiya, J. 1981. The nature of respiratory changes associated with sleep onset. *Sleep.* 4-1: 49.

42. Van Doornen, L. 1980. The coronary risk personality: psychological and psychophysiological aspects. *Psychother. Psychosom.* 34: 204.