AD-A136 528 COMPARISON OF BEHAVIORAL TREATMENTS FOR RAYNAUD'S DISEASE(U) ARMY RESEARCH INST OF ENVIRONMENTAL MEDICINE NATICK MA J B JOBE ET AL. 1984 USARIEM-M-8/84 1/1

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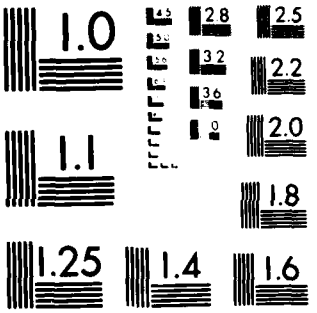

Comparison of Behavioral Treatments for Raynaud's Disease

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER M8/84	2. GOVT ACCESSION NO. AD A136528	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Comparison of Behavioral Treatments for Raynaud's Disease		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Jared B. Jobe, James B. Sampson, Donald E. Roberts and John A. Kelly		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Research Institute of Environmental Medicine Natick, MA 01760		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Health & Performance Division		12. REPORT DATE
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Induced vasodilation by classical conditioning was compared to biofeedback therapy as treatment for idiopathic Raynaud's Disease. Classical conditioning therapy consisted of 54 10-min immersions of both hands in water (43°C) simultaneously with whole body exposure to cold air (0°C), given three time per day, three days per week for six weeks. Biofeedback therapy consisted of eight sessions of electromyograph feedback (frontalis) while listening to relaxation tapes, followed by 10 sessions of digital thermal feedback while listening to relaxation tapes. Both groups received 10-min cold stress tests of whole body

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exposure to 0°C before and after treatments. Results indicated that both therapies significantly increased digital temperature response to cold. Although no differences between classical conditioning and biofeedback were found at the end of training, one-year follow up indicated that classical conditioning was more effective.

Abstract

Induced vasodilation by classical conditioning was compared to biofeedback therapy as treatment for idiopathic Raynaud's disease. Classical conditioning therapy consisted of 54 10-min immersions of both hands in water (43°C) simultaneously with whole body exposure to cold air (0°C), given three times per day, three days per week for six weeks. Biofeedback therapy consisted of eight sessions of electromyograph feedback (frontalis) while listening to relaxation tapes, followed by 10 sessions of digital thermal feedback while listening to relaxation tapes. Both groups received 10-min cold stress tests of whole body exposure to 0°C before and after treatments. Results indicated that both therapies significantly increased digital temperature response to cold. Although no differences between classical conditioning and biofeedback were found at the end of training, one-year follow up indicated that classical conditioning was more effective.

Raynaud's disease is characterized by extreme vasospastic attacks of the hands and/or the feet. Attacks are precipitated by cold or emotional distress, and are more likely to affect women than men. Typically, episodes are accompanied by a serial tricolor skin change (white pallor-cyanotic blue-deep red). Raynaud's attacks may be idiopathic or secondary to occlusive vascular disease or connective-tissue disease, the latter being referred to as Raynaud's phenomenon (1-2). Medical treatment of Raynaud's disease involves avoidance of cold and emotional upset, vasodilating drugs, plasmapheresis (3), calcium channel blocking agents (4), thyroid hormone (5), reserpine, and sympothectomy (2). In more recent years, behavioral treatments have been widely used in management of Raynaud's disease (6).

The most widely known method of behaviorally increasing blood flow to the hands is biofeedback, involving operant conditioning (7). Vasodilation via biofeedback has also been successfully demonstrated in a cooling environment (8-9). Attempts to apply these procedures to patients with Raynaud's disease have been moderately successful, with some studies combining biofeedback with other treatment modes (6, 9-10).

Hypnosis and relaxation have also received attention as treatments for vasoconstrictive syndromes (11). Surwit, Pilon, and Fenton (12) compared feedback plus autogenic training to autogenic training alone. They found increases in skin temperature and decreases in vasospastic attacks, with no improvement with the addition of feedback. One year follow up (13) of 19 of these subjects indicated that performance on the cold stress test had deteriorated to pre-treatment levels, although subjects did report fewer vasospastic attacks. Keefe, Surwit & Pilon (14) found that progressive muscle relaxation, autogenic training, and autogenic training plus feedback increased digital temperatures and decreased vasospastic attacks equally well.

Marshall and Gregory (15), using classical conditioning, found large increases in skin temperature and nerve-conduction velocity. Eight cold hypersensitive subjects, three of whom exhibited idiopathic Raynaud's disease, were given six simultaneous pairings of a whole-body-cold exposure of 0°C (conditioned stimulus) and a mild directed heat to the hands of 42°C (unconditioned stimulus). Jobe, Sampson, Roberts, and Beetham (16) found that subjects with Raynaud's disease who were treated with classical conditioning therapy (27 treatment), showed significant improvement compared to untreated Raynaud's subjects. Overall, 13 of 17 idiopathic Raynaud's subjects showed large increase in skin temperatures.

Except for the Jobe et al. study, most of the above studies used small numbers of subjects, or did not employ control groups. Many of these studies used subjective measures as indication of improvement. For those few studies which measured skin temperature during cold stress, only mild cold challenges (16-17°C) were employed.

The purpose of the present study was to compare classical conditioning therapy with biofeedback plus relaxation as treatment for idiopathic Raynaud's disease. It was also designed to evaluate the ability of biofeedback-trained patients to maintain skin temperature under more severe cold conditions (0°C) than have been previously studied.

METHOD

Subjects

Three male and 12 female volunteers (ages 14-61 years) from the local population were studied, and were modestly reimbursed for their participation. All subjects were diagnosed as having idiopathic Raynaud's disease according to the criteria of Allen and Brown (17). One subject did not complete the study and his data are not included in the analysis.

Each volunteer was interviewed, given a physical examination, and had a medical history taken. During the interview the subjects completed the Institute for Personality and Ability Testing (IPAT) Anxiety Scale Questionnaire (18), the Eysenck Personality Questionnaire (19), a background questionnaire and an environmental history questionnaire. To rule out possible complicating disease, all subjects had tests for rheumatoid factor, cold agglutinins, cyroglobulins, sedimentation rate, antinuclear antibody, and serum glucose levels. All test results were within normal limits.

Instrumentation: The temperature reponse of the fingers to cold air before and after treatment was used as the dependent variable. Research has shown that a high correlation exists between blood flow and skin temperature at low temperatures (20). Finger temperature was measured by thermocouples attached to the dorsal aspect of each finger (excluding thumb) proximal to the nail bed. Each subject was also fitted with a thermocouple rectal probe and an eight-point thermocouple harness to determine a mean-weighted-skin temperature. The eight points monitored were chest, lower back, abdomen, lateral upper arm, forehead, dorsal contralateral forearm, anterior thigh, and lateral calf. Temperatures were monitored continuously by a Leeds and Northrup Digimax Scanning Numatron and were collected by an on-line computer with temperature recordings reported very 60 secs.

Warm water for hand immersions was provided by two in-house fabricated stainless steel water baths each equipped with a plexiglass lid with two openings for the subject's hands, and controlled by a Braun Thermomix 1460 proportional controller and stirrer. Two in-house fabricated hot air baths were also used, each equipped with a Proportional Control, Model 72, manufactured by the Yellow Springs Instrument Co., Yellow Springs, OH.

Thermal feedback was provided by an Autogen 1000b feedback thermometer, and electromyograph feedback was provided using an Autogen 1100. Relaxation was induced using the Quieting Response Training audio cassette tapes from BMA Audiocassette Programs, New York, NY.

Procedure: The study was conducted from January 1982 through March 1982, with treatments for both groups given on Mondays, Wednesdays, and Fridays, three per day, for six consecutive weeks. The week before treatments began all subjects were tested to determine their digital temperature response to cold. On these days the subjects were seated in a room at 23°C for 30 minutes to stabilize body temperatures. No external heating was applied to the subjects. They were exposed to a single, 10-minute period of cold (0 ± 1°C) dressed in indoor clothing (light coveralls and boots), seated on a stool with arms at heart level. Digital temperature was recorded during the last minute of exposure. The cold test was repeated the week after the conclusion of treatments. The main comparison for evaluating the treatment effects were these pre- and post-treatment tests.

For the classical conditioning group, on each treatment day the subjects received three treatment administrations. Each subject changed into the coveralls and boots, and was then equipped with thermocouples. Before entering the cold chamber, the subject sat in a warm room (22 ± 1°C) and placed both hands in a box containing warm circulating air (49 ± 1°C) to induce vasodilatation. The subjects then entered the cold chamber (0 ± 1°C) and immediately placed both hands in a water bath (43 ± 1°C) for 10 minutes. After each treatment the subject was taken from the cold chamber for five minutes and again placed both hands in the warm air box. This procedure was repeated twice for a total of three trials on each experimental day. Finally, the temperatures of the subject at room temperature (23 ± 1°C) were monitored for five minutes.

For the biofeedback plus relaxation group the subject waited in a warm room (22 $\pm$ 1°C) for thirty minutes in order to acclimate to room temperature on each treatment day. The subject, dressed in street clothes, then entered a sound-proofed room (24 $\pm$ 1°C), sat in a well padded chair and listened to relaxation tapes while receiving electromyograph feedback from the frontalis area of the head (8 sessions) and thermal feedback from the middle finger of the dominant hand (10 sessions), each session lasting 45 min-1 hr. At the conclusion of the training series, all subjects were given a copy of the last audiocassette and were requested to practice the exercises at home.

On the last day of the experiment and approximately one year later, all subjects completed a questionnaire or interview rating the severity of their vasospastic attacks, the amount of pain experienced during an attack, and an estimate of the time it took their hands to recover from the attacks. These characteristics were rated on a 5 point scale, with 5 being most improved, 3 being about the same, and 1 being worse than before treatments. All subjects returned the questionnaires.

Statistical Analysis: All data analyses were done using mean digital temperatures of the dominant hand at the end of the exposure to cold as the dependent measure. Data were analyzed using a one-way analysis of covariance (ANCOVA) with the subject's digital temperature on the before cold exposure as the covariate and the temperature on the after treatment cold exposure as the dependent variable. Other comparisons were done using Student's t-test.

Results

Individual characteristics of the subjects are presented in Table 1. There were significant increases in mean digital temperatures during cold exposure between the cold test before treatments and the cold test after treatments for both treatment groups. Those treated with classical conditioning therapy showed

a mean increase of 3.9°C (t (5) = 4.44, $p < .01$), whereas the group treated with biofeedback and relaxation training showed a mean increase of 4.1°C (t (7) = 5.71, $p < .002$). Individually, five of six subjects in the classical conditioning group showed increases of greater than 2°C (the other subject was later found to be pregnant), and six of eight subjects in the biofeedback and relaxation group showed an increase of greater than 2°C. None of the classically conditioned subjects and two of the feedback subjects (B5, B6) had attacks of Raynaud's during the post test. There were no differences between the classical conditioning group and the biofeedback-relaxation group in digital temperatures on the post test ($F < 1$).

Subjective reports from both groups are presented in Table 2. Results suggest that individuals in the classical conditioning group had less pain during their attacks than the feedback group (t (12) = 2.27, $p < .05$), but there were no differences between the two groups in terms of severity of and recovery from the attacks. Results from the questionnaire sent out after one year suggest that the classical conditioning group had less severe attacks than the feedback group (t (12) = 2.99, $p < .05$), but that the groups did not differ in terms of painfulness of the attacks nor time to recover. Biofeedback-relaxation subjects were, in addition, asked whether the continued to practice the "quieting response" using the tape they were given. Five out of eight indicated that they still listened to the tapes.

Contrary to the early literature, there was no evidence that subjects with Raynaud's disease who participated in this study were less emotionally stable than the normal population. Anxiety scores as measured by the Anxiety Scale Questionnaire (mean score = 24.1) did not differ substantially from the normal values of the test (27.1). Similary, the subjects' scores on the "neuroticism" scale of the Eysenck Personality Questionnaire (mean socre = 7.13) did not differ from the normal values of the test (8.51-13.28).

Discussion

Subjects with Raynaud's disease showed significantly higher digital temperatures when exposed to cold after treatment with either classical conditioning procedures or a combination of biofeedback and relaxation training. Both treatments appear to be equally effective based on digital temperature data. The subjective reports from subjects indicate that classical conditioning had affected a reduction in painful attacks compared treated with biofeedback. The results also suggest that classical conditioning may have a more enduring effect, as evidenced in the one year follow up survey data. This later result is consistent with findings of Keefe, Surwit, & Pilon (13) who reported that patients treated with biofeedback and/or autogenic therapy, returned to baseline after one year. These findings are possibly attributable to the failure to consistently practice relaxation procedures by the subjects.

The data presented here give further support to the findings of our earlier research (16). In the present study, subjects were given 54 conditioning trials with a mean increase in digital temperatures from the pretest to the posttest of 3.9°C. In the earlier study, subjects received 27 conditioning trials and the improvement averaged 2.2°C. Thus, the increase in the number of treatments resulted in nearly double the increase in digital temperature. Although it is unclear at this point what the upper limit of improvement might be, the maximum would be that obtained by fully dilated circulation to the hands. As in the previous study, one year follow-up indicated that the conditioning treatments had long-lasting effects.

The present results are also consistent with our earlier work (16) in that no differences were found between subjects with Raynaud's disease and test norms for two measures of emotional stability. There thus appears to be no basis, at least in our estimation, for the conclusion that patients with Raynaud's disease are emotionally unstable as a group (2).

Acknowledgements: The authors thank Patricia Burden, M.D., Paul Rock, D.O., Ph.D., and Bruce H. Jones, M.D. for serving as medical monitors and doing physical examinations; David L. Moore for performing venipunctures; Heidi Weiss for analyzing blood tests; Heidi Weiss, Jolene Rolands, and James McDevitt for technical assistance with treatments; Warner H. Pierce and Mark W. Sharp for technical assistance with subject evaluation; William P. Beetham, Jr., M.D., for consultations on patients; and Susan Sibson and Julie Cyphers for preparing the manuscript.

TABLE 1

Individual Data of Raynaud's Afflicted Subjects

Subject	Age/Sex	Years Since Onset	Smoker	Family History of Raynaud's Disease*	Mean Digital Temperature Before Treatments	Mean Digital Temperature After Treatments
Classical Conditioning Group						
C2	36/F	3	No	No	6.2	10.5
C3	47/F	10	No	S	5.9	9.1
C4	36/F	7	No	S	12.3	12.3
C5	28/F	5	No	No	3.5	8.1
C6	44/F	7	No	A	4.7	11.1
C8	51/F	12	No	No	5.4	10.0
Biofeedback-Relaxation Group						
B1	20/F	10	No	GP,P,A,C	5.3	7.3
B2	45/M	17	Yes	No	8.3	13.2
B3	17/F	2	No	GP	5.4	12.2
B4	43/F	22	No	O	6.3	12.1
B5	61/M	15	No	No	9.5	12.5
B6	42/F	2	Yes	No	8.0	9.3
B7	68/F	36	No	C	5.3	10.9
B8	14/F	7	No	GP	8.1	11.1

*A - Aunt
C - Cousin
GP - Grand Parent
O - Offspring
P - Parent
S - Sibling

Table 2

Subjective Results

Subject	End of Training			One Year Following		
	Severity	Pain*	Recovery Time	Severity*	Pain	Recovery Time
Classical Conditioning Group						
C2	4	4	4	4	4	3
C3	5	4	4	5	5	5
C4	4	4	4	5	5	5
C5	4	4	4	5	2	5
C6	4	4	4	5	3	5
C8	4	4	4	5	5	5
Biofeedback Relaxation Group						
B1	4	4	4	3	3	3
B2	4	3	4	4	4	5
B3	4	4	4	5	5	4
B4	4	3	3	4	4	3
B5	3	3	3	4	5	5
B6	4	4	4	4	4	4
B7	4	3	4	2	3	2
B8	3	4	4	3	4	4

*$p < .05$

1 = Much more
2 = More
3 = No change
4 = Less
5 = Much Less

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