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THE COMPARATIVE EFFICACY OF TWO BIOFEEDBACK TECHNIQUES IN THE TREATMENT OF GENERALIZED ANXIETY DISORDER

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The present study compared the efficacy of two most commonly used biofeedback relaxation techniques in the treatment of Generalized Anxiety Disorder (GAD). Forty five individuals, recruited on the basis of Diagnostic and Statistical Manual of Mental Disorders-IV Text Revision criteria (DSM-IV-TR; APA, 2000) were randomly assigned to three groups: Group I (n = 15) received Electromyographic (EMG) biofeedback relaxation training; Group II (n = 15) received Alpha–Electroencephalographic (EEG) biofeedback relaxation training; and Group III (n = 15) was a control group. Both EMG and EEG groups resulted in more consistent pattern of generalized relaxation changes reflected in alpha-EEG activity, frontalis-EMG activity, systolic blood pressure and Comprehensive Anxiety Test (CAT) score as compared to control group. Significant changes were also observed on comparing EMG and EEG groups. At follow-up, maintenance of effects was observed in both treatment groups.

Generalized Anxiety Disorder (GAD) is a prototypical anxiety disorder twice more common in women than in men (Hidalgo & Davidson, 2001). Criteria for the diagnosis of GAD emphasize the presence of unrealistic or excessive worry and apprehension (DSM-IV-TR; APA, 2000). The symptoms of GAD are commonly found in a primary care setting with associated somatic symptoms; including restlessness, fatigability, difficulty in concentrating, irritability, muscle tension and sleep disturbances. Patients of GAD generally experience great impairment in their social and physical functioning; therefore, it is imperative to search for an effective modality for its treatment (Culpepper, 2002).

Psychotherapy has shown long term benefits in the treatment of GAD and may be useful approach alone and as an adjunct to pharmacotherapeutic options (Allgulander et al., 2003; Durham, 2007; Falsetti & Davis, 2001; Gorman, 2002; Siev & Chambler, 2007). The current treatment models of GAD focus on several related cognitive behavioral treatments.

EMG biofeedback mediated relaxation is an extension of progressive relaxation and autogenic training (Townsend, House, John, & Addorio, 1975). On the other hand, EEG biofeedback or Neuro-feedback training is an encouraging development that holds promise as a method for modifying biological brain patterns associated with a variety of psychological

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and physical disorders particularly because it is non-invasive and seldom associated with even mild side effects (Hammond, 2005).

An ample volume of literature shows a particularly positive research support for EMG biofeedback (Raskin, Bali, & Peeke, 1980; Rice & Blanchard, 1982) as well as EEG biofeedback relaxation trainings in the treatment of anxiety disorders (Hardt & Kamiya, 1978; Moore, 2000; Moore, 2005; Vanathy, Sharma, & Kumar, 1998). In the past few decades, research has compared the effectiveness of various biofeedback trainings to other conventional methods of relaxation. However, very little research has compared the effectiveness of various biofeedback relaxation techniques in the treatment of anxiety disorders. Moreover, much of the research work in this arena has occurred before 1990's, with practically very few published studies in the intervening years (Moore et al., 2000; Rice, Blanchard, & Purcell, 1993; Thomas & Sattleberger, 1997). The ongoing research, thereafter, has shifted its focus on investigating the application of biofeedback in the treatment of other disorders.

The literature documents EMG biofeedback training is more effective method of relaxation than EEG biofeedback training for drug users as well as normal subjects (DeGood & Chisholm, 1977; DeGood & Edward, 1981; Lamontagne, Hand, Annable, & Gagnon 1977; Rice & Blanchard, 1982). An eminent work in this field has been done by Rice, Blanchard, & Purcell (1993) who compared the efficacy of EMG biofeedback and EEG increase and decrease biofeedback treatments in generalized anxiety patients. Significant decrease in anxiety as given in self report was observed in all treatments groups. However, no significant results were yielded in between group comparisons. The reason for such findings can be attributed to the small sample size and shorter treatment duration. Moreover, all subjects did not have diagnosable level of GAD. Furthermore, most of the research on biofeedback treatment of GAD has been done prior to publication of DSM-IV-TR (APA, 2000).

In the light of above review, the present study was undertaken to compare the efficacy of 12 sessions (25 minutes daily) of alpha-EEG increase biofeedback and frontalis-EMG decrease biofeedback trainings each on alpha-EEG activity, frontalis-EMG activity, blood pressure and CAT score in the patients of GAD as defined by DSM-IV-TR criteria. The following hypotheses were sought to be tested: First, both training groups will show decreased level of anxiety post training as compared to the control group. Second, any of the two training groups may be better in reduction of anxiety levels.

Method

Sample

Announcements in the community were made about the availability of relaxation therapy for generalized anxiety problems of 18-30 years age-group. Out of 45 individuals (24 females and 21 males), 15 each were randomly assigned to (a) Group-I: EMG biofeedback group; (b) Group-II: EEG group and (c) Group-III: control group.

Inclusion Criteria

Inclusion Criteria was based on a semi-structured interview conducted to screen out the patients of GAD using DSM-IV-TR criteria.

Exclusion Criteria

Subjects already practicing any form of relaxation technique or depending on anxiolytics were excluded.

Instruments

The following parameters were assessed at pre- and post-treatment.

1. *Comprehensive Anxiety Test (CAT) Questionnaire (Sharma, Bhardwaj, & Bhargava, 1992)*

CAT score was calculated using a self-report measure. Anxiety of both the covert and overt type and state and trait type is measured by this test. Reliability coefficient of test is found to be .83 by test-retest method and .94 by split half method. Validity of the test is determined by computing the correlation scores of the present test and other tests like STAI (r = .82) and anxiety dimension of eight state questionnaire 'form A' (r = .74). The chosen test is particularly useful and administration age range is 18-50 years for males and females, which covers the age limit selected for the study.

2. *Alpha-EEG activity* was measured in micro-volts with Medicaid system Alpha-EEG Biofeedback Biotrainer EBF-5000.

3. *EMG activity* of frontalis muscle was recorded in micro-volts with Medicaid system EMG biofeedback Biotrainer MBF-4000.

4. *Systolic blood pressure* was measured with sphygmomanometer.

Procedure

The study was approved by Institutional Medical Ethics Committee of Guru Nanak Dev University, Amritsar, prior to the start of data collection. Patients were explained about the training and previous research supporting the effectiveness of biofeedback training in causing relaxation. Only subjects who volunteered to participate in the study were recruited. A written informed consent was taken from each subject prior to the beginning of the training. Patients in two experimental groups were treated individually for 12 successive days at Sports Psychology Laboratory, Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar. The treatment was given under controlled conditions. All treatment sessions, except the first and last, lasted approximately for 35 minutes as the assessment was done on day 1 as well as day 12. After the application of electrodes, the patient was asked to sit comfortably for a 5 minute baseline period. Then, followed a 25 minute phase of either of two biofeedback trainings. All the patients were asked to practice relaxation at home once a day for 25 minutes. It was determined by the therapist whether each patient regularly practiced at home throughout the treatment period. The patients in the control group were given no treatment. All the parameters were measured on day 1 and day 12. However, the participants were taught Jacobson's Progressive Muscle Relaxation after the completion of study on ethical grounds.

Frontalis EMG Biofeedback Training

A Medicaid system EMG Biofeedback Biotrainer MBF-4000 device was used. The feedback was a visual display with 17 bars (11 green on left, 1 yellow in middle, and 5 red at right). The display showed green bars with decrease and red with increase in tension of frontalis muscle, respectively. The patient was instructed to glow the green bars and not let the red bars to glow. Intermittent positive verbal reinforcement was provided every few minutes by the therapist.

Alpha – EEG Biofeedback Training

Visual alpha enhancement biofeedback training was given to the subject. A Medicaid Alpha-EEG Biofeedback Biotrainer EBF-5000 device was used. The feedback display was similar to EMG feedback. The display showed green bars with increase and red with decrease in amounts of alpha activity, respectively. Similar positive intermittent instructions as for EMG group were given every few minutes by the therapist.

Follow-up

Two weeks after the completion of training all the patients of both treatment groups were again called for measurement of all the parameters.

Results

Intra-group comparisons were analyzed using paired t-test. Multivariate ANOVA and Post Hoc Multiple Scheffe Tests were done pre- and post-treatment to find changes between the groups.

CAT Score

Table 1 shows MANOVA comparison at pre-treatment which yielded non significant differences between the groups, $F = 2.70$, $p > .05$. Intra group comparison of all three groups are shown in Figure 1, which revealed statistically significant decrease in CAT score in EMG, $t = 9.12$, $p < .001$ and EEG, $t = 7.46$, $p < .001$, groups, while control group did not change significantly. MANOVA followed by Post Hoc Multiple Scheffe Range Test at post-treatment in Table 1 yielded EMG group to be at statistically most significant level of relaxation followed by EEG group, $F = 26.25$, $p < .05$.

Alpha-EEG activity

Table 1 shows that the three groups did not differ statistically ($p > .05$) at pre-treatment.

MANOVA at post-treatment with Post Hoc Multiple Scheffe Range Test, $F = 153.37$, $p < .001$, indicated EEGgroup to be at most significant level of relaxation followed by EMG group as shown in Table 1. Pre- to post-treatment comparison for EMG, $t = 15.81$, $p < .001$, and EEG, $t = 13.73$, $p < .001$, groups revealed statistically significant increase in alpha-EEG

Table 1

MANOVA between All Groups at Pre and Post-Treatment

Parameters		*SS*	*MS*	*F*
EEG	Pre-treatment	181.64	90.82	0.50
	Post-treatment	80.36	40178.87	153.37**
EMG	Pre-treatment	22.71	11.35	2.15
	Post-treatment	485,96	242.98	56.18**
Systolic Blood pressure	Pre-treatment	70.93	35.47	0.25
	Post-treatment	13333.51	666.76	4.05*
Diastolic blood pressure	Pre-treatment	236.98	118.49	1.10
	Post-treatment	526.80	263.40	2.67
CAT Score	Pre-treatment	212.13	106.07	2.70
	Post-treatment	2730.53	1365.27	26.25**

*$p < .05$. **$p < .001$.

Figure 1

Intra Group Comparisons of Three Groups for Alpha-EEG Activity

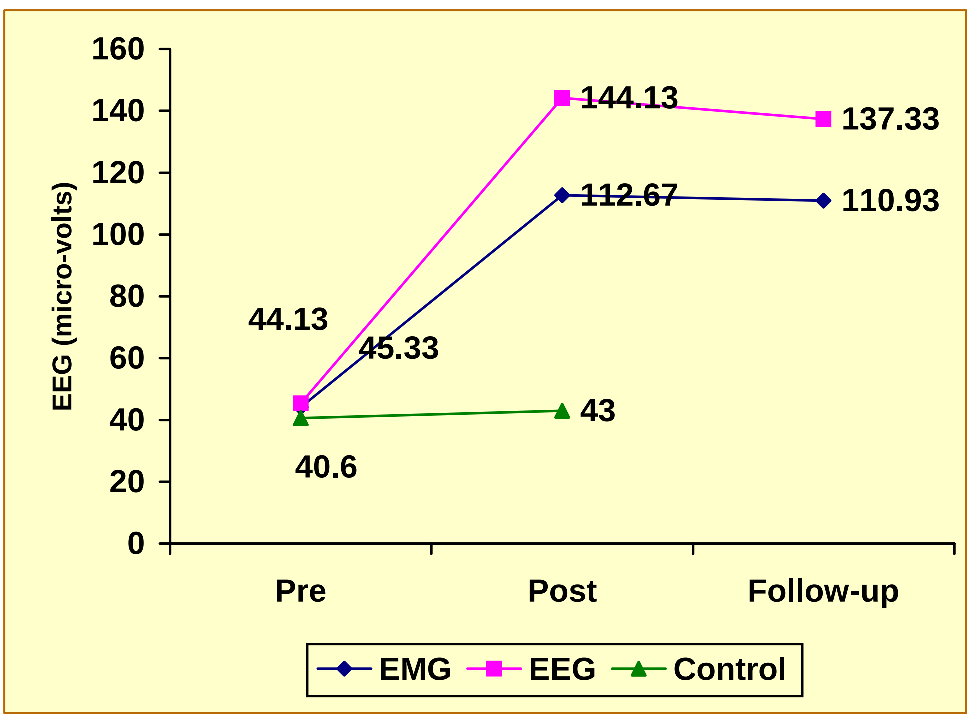


Figure 2

Intra Group Comparisons of All Three Groups for Frontalis-EMG Activity

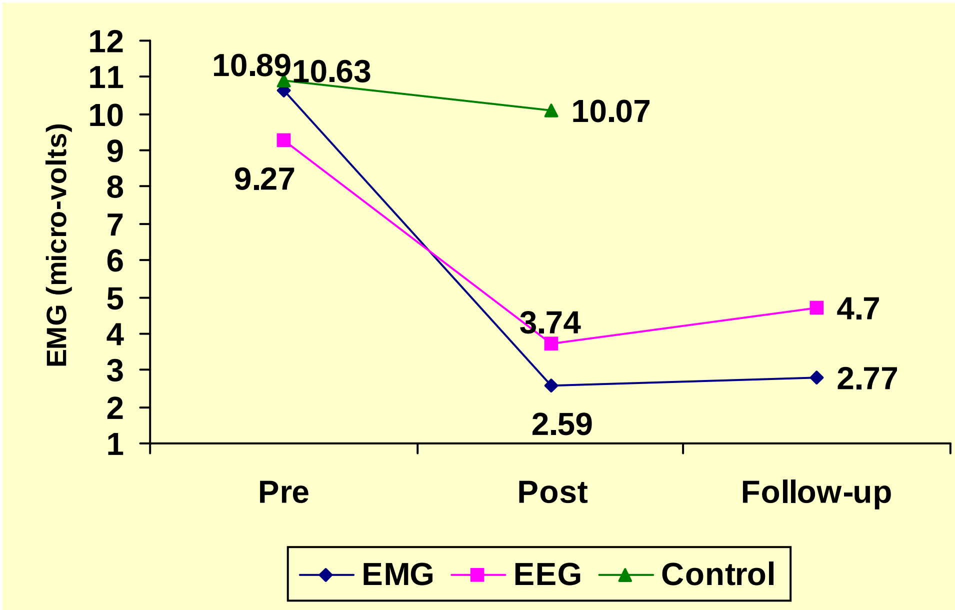
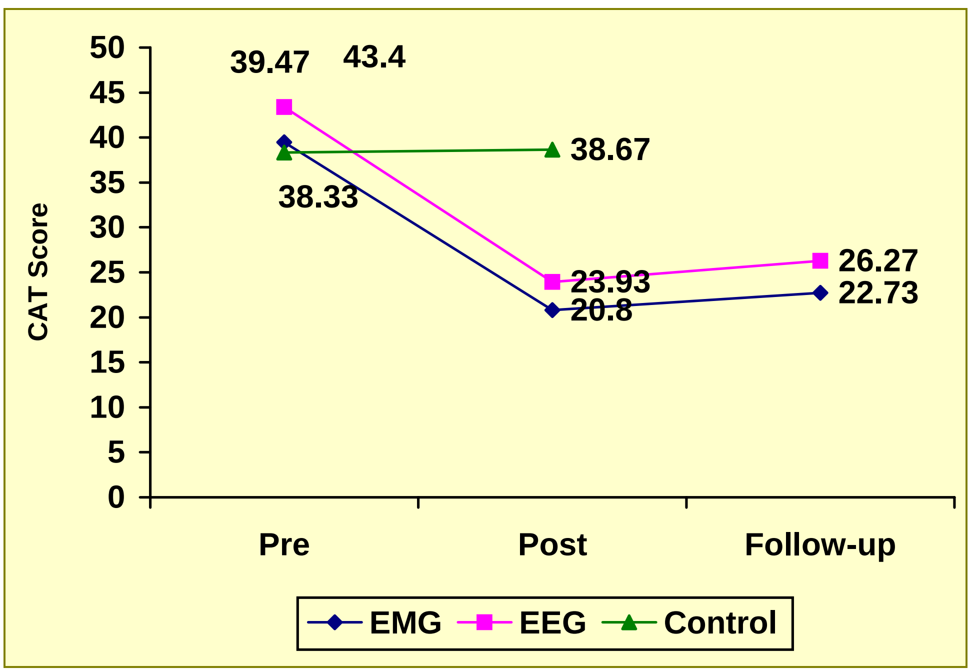


Figure 3

Intra Group Comparisons of All Three Groups for CAT Score



activity (micro-volts), while control group, $t = 1.41$, $p > .05$, showed non-significant changes as shown in Figure 2.

Frontalis EMG Activity

MANOVA comparison of all three groups showed non-significant differences ($p > .05$) at pre-treatment. Intra group comparison showed statistically significant reduction in frontalis-EMG activity (micro-volts) in EMG, $t = 19.37$, $p < .001$, and EEG, $t = 9.39$, $p < .001$, groups, while control group did not show statistically significant changes. The results are depicted in Figure 3. MANOVA with Post Hoc Multiple Scheffe Range Test at post-treatment, $F = 56.18$, $p < .001$, showed most significant reduction in frontalis-EMG activity in EMG group followed by EEG group.

Systolic Blood Pressure

Table 1 further shows that MANOVA comparison at pre-treatment, $F = 0.25$, $p > .05$, yielded non-significant differences between and within groups, whereas at post-treatment, $F = 3.55$, $p < .05$, EMG group appeared to be at statistically most significant level of relaxation followed by EEG group.

Diastolic Blood Pressure

MANOVA comparison of all three groups showed non-significant differences ($p > .05$) at pre-treatment, indicated in Table 1. Intra group comparison of all three groups revealed statistically significant reduction in diastolic blood pressure in both EMG, $t = 7.94$, $p < .001$, and EEG groups, $t = 7.31$, $p < .001$, while control group, $t = .47$, $p > .05$, did not show any statistically significant changes. MANOVA comparison at post treatment with Post Hoc Multiple Scheffe Range Test, $F = 2.67$, $p > .05$, did not show statistically significant differences between the groups.

Follow-Up

At two weeks follow-up, EMG group was at statistically higher level of relaxation for frontalis-EMG activity, $t = 3.20$, $p < .05$, as compared to EEG group, while EEG group was found to be at higher level of relaxation for alpha-EEG activity, $t = 3.79$, $p = .001$, as compared to EMG group; results are summarized in Table 2.

Discussion

The between group comparisons depicted that EMG group (47.30%) was most effective in reducing CAT score as compared to EEG (44.86%) and control (0.89%) groups. These percentages were computed separately. A positive correlation is believed to exist between changes in muscle tension and self reported anxiety symptoms. Rice et al. (1993) observed significant reductions in self reported anxiety measures in all biofeedback treatment groups. Ossebaard (2000) observed a significant immediate decrease in state anxiety with alpha feedback training. Wenck et al. (1996) observed analogous results in state and trait anxiety with EMG and thermal biofeedback.

Percentages were computed separately. EEG group (217.95%) was most effective in enhancing alpha

Table 2

Inter Group Comparison for Alpha-EEG, Frontalis-EMG, Blood Pressure and CAT Score at Follow-up between EMG and EEG Groups

Parameters	EMG Group		EEG Group		*t*
	M	*SD*	*M*	*SD*	
Alpha-EEG (micro-volts)	110.93	12.15	137.33	24.13	3.79**
Frontalis-EMG (micro-volts)	2.77	1.13	4.70	2.05	3.20*
Systolic blood pressure (mmHg)	118	12.56	117.20	6.75	0.22
Diastolic blood pressure (mmHg)	74.80	9.56	77.20	4.95	0.86
CAT score	22.73	7.28	26.27	8.41	1.23

*$p < .05$. **$p < .001$.

EEG activity followed by EMG group (155.31%) while, EMG group (75.64%) was most effective in reducing frontalis-EMG activity followed by EEG group (59.65%). A feedback facilitates learning of any skill. Thus, feedback of physiological information of the patient assists him in gaining the self-regulation of the particular physiological process being monitored (Biswas, Biswas, & Chattopadhyay, 1995; Wenck, Len, & D'Amato, 1996). Substantial amount of research supports the findings of the present study (DeGood & Chisholm, 1977; Hardt, & Kamiya, 1978; Moore et al., 2000; Rice, Blanchard, & Purcell, 1993; Vanathy, Sharma, & Kumar, 1998; Sarkar, Rathee, & Neena, 1999).

A significant reduction in systolic blood pressure occurred in both EMG (10.18%) and EEG (10.13%) groups as shown through percentages calculated separately while control group showed a change of 1.20% only. For diastolic blood pressure, percentage decreased from pre- to post-treatment for EMG, EEG and control groups was found to be 14.40%, 11.45% and 1.20%, respectively. According to Singh and Sahni (2000), an increase in sympathetic activity increases heart rate, stroke volume and peripheral blood flow. One can monitor and through relaxation, control the effects of stress, tension or anxiety. The extensive research work done in past on the impact of biofeedback training on hypertensives provides sufficient evidence to support these results (Blanchard, Haynes, Kallman, & Louis 1976; Datey, 1980; Jacob, Kraemer, & Agras, 1977; Najafian, & Hashemi, 2006; Taylor, Farquhar, Nelson, & Agras, 1977).

At follow-up, EMG group showed a change of 1.54% in alpha-EEG activity, 6.94% in frontalis-EMG activity, 5.61% in systolic blood pressure, 4.36% in diastolic blood pressure and 9.27% in CAT score while EEG group showed a change of 4.71% in alpha-EEG activity, 25.66% in frontalis-EMG activity, 4.27% in systolic blood pressure, 3.95% in diastolic blood pressure and 9.78% in CAT score. Lamontagne et al. (1977) observed analogous findings. The reason for slight decrement at follow-up may be that the patients did not practice at home post-treatment. However, mean values indicated a significant level of relaxation as compared to pre-treatment values. Therefore, willingness on the part of the patient to participate in the treatment process, including compliance with home practice, has a specific impact on the treatment efficacy of these techniques.

Decreased muscle tension through EMG biofeedback training leads to generalization of relaxation by decreasing the signs of sympathetic and increasing the parasympathetic tone as well as by deactivation of hormonal signs of hypothalamic-pituitary adrenal axis. A similar belief was proposed by Khanna, Paul, and Sandhu (2007) for progressive muscle relaxation training. Sahni (2005) suggested that achievement of deep muscle relaxation with electromyographic feedback can contribute to overall level of relaxation and have significant clinical impact on stress related disorders.

EEG biofeedback training leads to operant conditioning and has been found to be effective in modifying brain functions associated with mental health and medical disorders (Hammond, 2005).

Conclusions

From the present study, it can be concluded that biofeedback treatment demonstrably leads to reduction in the anxiety levels. However, biofeedback training should be used in a manner specific to the individual patient's psychophysiological profile, i.e., patients experiencing symptoms of muscle tension should be treated with EMG biofeedback to reduce their muscle tension. An EEG component should be added, if assessment documents cerebellar dysfunction. Therefore, a thorough evaluation of each patient is mandatory before deciding the appropriate biofeedback treatment for him. An attempt was made to address the methodological limitations of previous research on biofeedback treatment of anxiety disorders.

Limitations

Nonetheless, the present study has certain limitations. The future research should focus on a longer treatment duration as well as follow-up. The comparative efficacy of alpha decrease and EMG decrease biofeedback relaxation trainings in the treatment of GAD also needs to be investigated. One avenue of additional investigation may be to assess whether serial application of EMG and EEG biofeedback relaxation trainings has any substantial effect on GAD patients.

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