Biofeedback Approach in The Treatment of Generalized Anxiety Disorder

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Objective: The present study compares the efficacy of two most commonly used biofeedback relaxation techniques in the treatment of Generalized Anxiety Disorder.
Method: 45 individuals with Generalized Anxiety Disorder were randomly assigned to three groups (n=15): Group I received electromyographic biofeedback relaxation training, Group II received alpha–electroencephalographic biofeedback relaxation training and Group III served as the control group.
Results: Both treatment groups resulted in more consistent pattern of generalized relaxation changes reflected in galvanic skin resistance, state and trait anxiety as compared to the control group. Significant changes were observed in galvanic skin resistance and trait anxiety in the electromyographic group as compared to the electroencephalographic group. At follow-up, maintenance of effects of treatment was observed in both treatment groups.
Conclusions: Both Biofeedback trainings are efficacious in the treatment of Generalized Anxiety Disorder.
Key Words:
Anxiety, Electroencephalography,Electromyographyy, Galvanic skin response Relaxation

Generalized anxiety disorder (GAD) is a common anxiety disorder that typically has an early age of onset, a chronic course and a high degree of comorbidity with other anxiety and mood disorders (1). The lifetime prevalence of GAD in general population is 4-7% (2). GAD is characterized by frequent, persistent worry and anxiety that is out of proportion to the impact of the event or circumstance that is the focus of the worry (3). The essential features of GAD include restlessness, fatigability, difficulty concentrating, irritability, muscle tension and sleep disturbances.

Effective treatment of GAD can be achieved with both pharmacological and non-pharmacological approaches (4, 5). Biofeedback therapies use scientific instruments to measure, amplify and feedback physiological information to the patient being monitored. The information assists the patient in gaining self regulation of the physiological process being monitored. Biofeedback training has been applied to the treatment of anxiety, mostly along two major lines: One is by reduction of muscle tension levels through electromyographic (EMG) biofeedback; the other is by Operant conditioning of brain wave activity through electroencephalographic (EEG) biofeedback.

EMG biofeedback mediated relaxation is an extension of progressive relaxation and autogenic training (6). The frontalis muscle ,one of the most difficult muscles in the body to relax voluntarily, is expected to generalize the relaxation to the whole body (7).

EEG biofeedback training is an encouraging development that holds promise as a method for modifying biological brain patterns associated with a variety of mental health and medical disorders particularly because it is non invasive and is seldom associated with even mild side effects (8).

An ample volume of literature shows a particularly positive research support for both EMG biofeedback (6, 9) as well as EEG biofeedback (10, 11) relaxation trainings in the treatment of anxiety disorders. The biofeedback treatment of anxiety disorders has been labeled as 'efficacious' on the rating criteria of Association for Applied Psychophysiology and biofeedback (12).

Much of the research work in this arena occurred during 1980's with practically no published studies in the intervening years. The ongoing research has shifted its focus on investigating the application of biofeedback in the treatment of other disorders. However, very little research has focused on the comparative efficacy of these biofeedback techniques in the treatment of anxiety disorders (13, 14). Majority of the research indicates that EMG biofeedback resulted in more consistent pattern of generalized arousal changes than EEG biofeedback training (15-17). However, few studies documented EEG biofeedback training to be better than EMG feedback (10, 18, 19).

The reason for ambiguity in literature can be attributed to various methodological limitations in these studies: First, small sample size; second, short treatment

duration (less than 5 hrs.); and third, incomplete follow-up data. Moreover, the subjects included in these studies did not have a diagnosable level of GAD. Furthermore, most of the research on biofeedback treatment of GAD has been done prior to publication of DSM-IV TR criteria.

In the lieu of the above issues, the present study was undertaken to compare the efficacy of 12 sessions each of which with a duration of 25 minutes (total training period=5 hrs) of both alpha-EEG increase biofeedback as well as frontalis-EMG decrease biofeedback trainings on galvanic skin resistance. This study also demonstrates trait anxiety in the treatment of GAD as diagnosed by DSM-IV TR criteria.

The following hypothesis were sought to be tested: First, both training groups will show decreased level of anxiety after 12 sessions (25 minutes each) of biofeedback training as compared to the control group. Second, any of the two training groups may be better in reduction of anxiety levels.

Materials and Methods
Participants
Announcements in the community were made about the availability of relaxation therapy for generalized anxiety problems of 18-30 years age-group. Individuals who contacted for the therapy were interviewed to screen out the patients of GAD on the basis of DSM-IV TR criteria. Out of 45 individuals (24 females 21 males), 15 subjects were randomly assigned to each of the groups: (a) Group-I: EMG biofeedback group; (b) Group-II: EEG group and (c) Group-III: control group.
Instrument
The following parameters were assessed at pre and post treatment.
Galvanic skin resistance was measured for physiological assessment with Medicaid GSR Biofeedback Biotrainer GBF-2000. GSR depicts the autonomic activity of sweat glands. In anxious patients, increased sweating led to reduction of resistance to galvanic current. With relaxation, as sweating decreased, GSR increased.
State and Trait anxiety scores were recorded using a standardized self-report measure State Trait Anxiety Inventory (20). This test is a self-report assessment device which includes separate measure of state and trait anxiety and has been particularly recommended for use in studying anxiety in research and clinical settings. Both percentile ranks and standard (T) scores are available for male and females working adults in three age groups (19-39, 40-49, and 50-69). The reliability coefficient of trait anxiety scale is 0.68 to 0.86, whereas range for state anxiety scale is 0.16 to 0.62. Validity of the scale as determined by computing the correlation scores of the present scale and other measures of trait anxiety like Taylor Manifest Anxiety Scale is r=0.80, Institute of Personality and ability Testing (IPAT) Anxiety Scale (r=0.75) and Multiple Affective Adjective Checklist (r=0.52).

The following instruments were used for treatment:
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.
A Medicaid Alpha-EEG Biofeedback Biotrainer EBF-5000 device was used. The feedback display was similar to EMG feedback.

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 on anxiolytics were excluded.

Procedure
The study was approved by Institutional Medical Ethics Committee of Guru Nanak Dev University, Amritsar prior to the start of data collection. . The patients were diagnosed using a semi-structured interview based on DSM-IV TR criteria. Patients of the both treatment groups were explained about the training and previous research supporting the effectiveness of biofeedback training in causing relaxation. Only individuals willing to participate in the study were recruited. A written informed consent was taken from each of the participants prior to the beginning of the training.
Patients in the 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 room was neat and clean with no disturbing sounds and glaring lights. All treatment sessions except the first and last lasted approximately for 35 minutes. After the application of electrodes, the patient was asked to sit comfortably for a 5 minute baseline period. There 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 strictly determined by the therapist whether each patient regularly practiced at home through out the treatment period.

Frontalis EMG biofeedback training
The patient was instructed to glow the green bars and not let the red bars to glow. The patient was instructed to find a way to glow green bars in order to relax himself. 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. The display showed green bars with increase and red with decrease in amounts of alpha activity respectively. Similar positive intermittent instructions as in EMG group were given every few minutes by the therapist.

Control group
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 the study on ethical grounds.

Follow-up
Two weeks after the completion of training all the patients of all the groups were again called for measurement of all the parameters

Statistical analysis
Intra comparisons were analyzed using paired t-test. Multivariate ANOVA and Post Hoc Multiple Scheffe Tests were done pre and post treatment as well as at follow-up to find differences between the groups.

Results
Galvanic skin resistance
The three groups did not differ statistically on pre treatment (Table 1). Pre to post treatment comparison for EMG (t=7.55, p<0.001) and EEG (t=6.75, p<0.001) groups revealed statistically significant increase in GSR values (kilo-ohms), while control group (t=0.43, p>0.05) showed non-significant changes (Figure 1). Multivariate ANOVA at post treatment yielded statistically significant differences (F=25.80, p<0.001) between groups. Post Hoc Multiple Scheffe Range Test revealed that EMG group showed most significant changes followed by EEG group.

State-Anxiety
Intra group comparison of all the three groups showed statistically significant reduction in state anxiety score in both EMG (t=8.09, p<0.001) and EEG (t=6.62, p<0.001) groups, while control group (t=0.15, p>0.05)
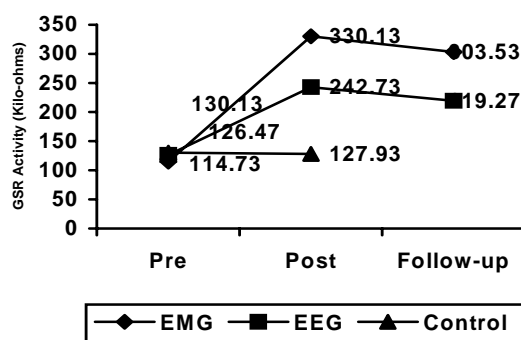

Figure 1. Intra group comparisons of all three groups for GSR activity
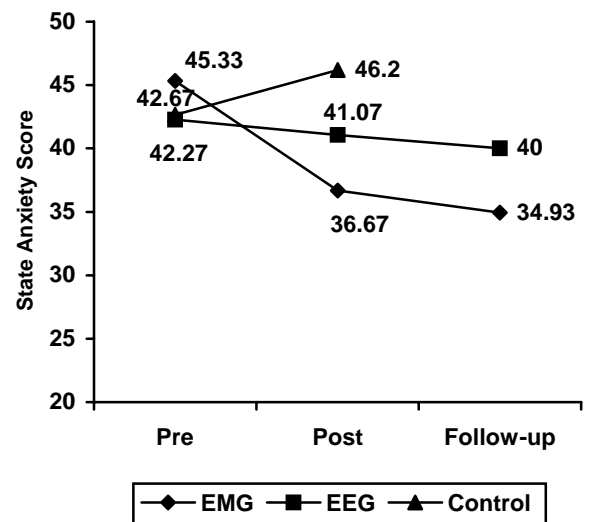

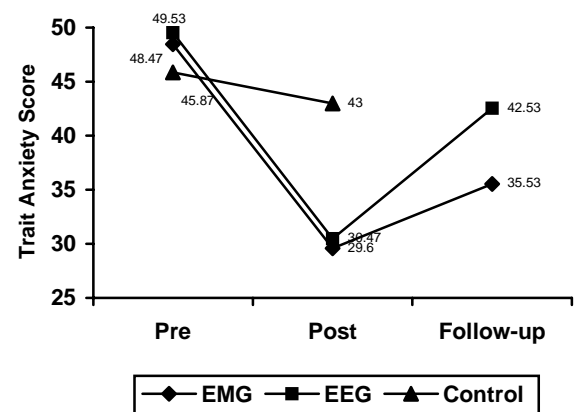**Figure 2. Intra group comparisons of all three groups for state anxiety scores**

Figure 3. Intra group comparisons of all three groups for trait anxiety score

did not change significantly (Figure 2). Multivariate ANOVA at pre-treatment yielded non significant (F=0.92, p>0.05) differences between the three groups. However, statistically significant differences (F=37.96, p<0.001) between the groups were observed at the post-treatment stage (Table 1). The results of the Post Hoc Scheffe Multiple Range Test indicated that both EMG and EEG groups had almost equivalent effect on state anxiety.

Trait-Anxiety
Multivariate ANOVA comparison of all the three groups showed non significant differences at the pre treatment stage (Table 1). Intra group comparison of all the three groups showed statistically significant reduction in trait anxiety score in both EMG (t=7.47, p<0.001) and EEG (t=6.41, p<0.001) groups, while control group (t=0.75, p>0.05) did not show any statistically significant changes (Figure 3). Multivariate

Table 1. Multivariate ANOVA comparison at pre and post treatment

Parameters		Sum of Squares	df	Mean Square	F
GSR	Pre-treatment	1941.38	2	970.69	1.23[NS]
	Post-treatment	308513.20	2	154256.60	25.80[**]
State Anxiety	Pre-treatment	83.38	2	41.69	0.92[NS]
	Post-treatment	1686.98	2	843.49	37.96[**]
Trait Anxiety	Pre-treatment	106.71	2	53.36	1.24[NS]
	Post-treatment	682.98	2	341.49	9.04[*]

* indicates p<0.05   ** indicates p<0.001   NS = Non-significant

ANOVA revealed a main effect at post treatment (F=9.04, p<0.05) between the groups.
Post Hoc Scheffe Multiple Range Test revealed that only EMG group showed significant decrease in trait anxiety scores.

Follow-up
Multivariate ANOVA comparison followed by Post Hoc Multiple Scheffe test revealed that EMG group was at significantly highest level of relaxation than EEG and control groups in GSR (F=18.98, p<0.001), state anxiety (F=7.56, p<0.05) and trait anxiety (F=9.17, p<0.001) respectively.

Discussion
The present study shows that both EMG and EEG biofeedback relaxation trainings resulted in remarkable improvement in galvanic skin resistance and significant decrease in state and trait anxiety after 12 days of treatment .
The specific between group comparisons depicted that EMG group (153.69%) was most effective in increasing GSR value followed by EEG group (91.92%).
The possible explanation may be that decreased muscle tension is related with signs of decreased sympathetic and increased parasympathetic tone and deactivation of hormonal signs of hypothalamic-pituitary-adrenal axis. Therefore, decrease in muscle tension by EMG biofeedback training may have led to generalization of relaxation by diminution of endocrine and autonomic responses (20-23). It has been 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 (24). A significant immediate decrease in state anxiety was observed with alpha biofeedback training (25.(
EMG group (34.70%) was most effective in reducing the state anxiety scores compared to EEG group (27.91%) and control group (0.7%). The percentage decrease in trait anxiety scores post treatment was 24.34% for EMG group, 17.08% for EEG group and 0.71% for control group. A positive correlation is believed to exist between changes in muscle tension

and self-reported anxiety symptoms.
Significant reductions in trait anxiety have been observed with both EMG and EEG biofeedback treatment groups (14). Analogous results in state and trait anxiety with EMG and thermal biofeedback have also been reported (26).
EMG group was successful in retaining the reduction only in trait anxiety scores at follow-up. The mean values changed only by 3.55% from post treatment to follow-up. Meanwhile, EEG group retained the improvement in GSR (8.06%) and trait anxiety scores (3.08%). Analogous findings have also been reported in past (16). The reason for decrement of effects at follow-up may be that the patients did not practice at home post treatment. However, EMG group was still at most significant level of relaxation as compared to EEG and control groups .
The underlying mechanism for significant effects of relaxation with EEG biofeedback may be that 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 (8). An ample volume of literature supports the efficacy of EEG neurofeedback training in the treatment of GAD (27, 28). GAD commonly presents with somatic symptoms (29). The somatic tension-relaxation learning by EMG biofeedback training may have led to more marked improvement than EEG biofeedback training which works as cognitive tension relaxation system. Similar results have also been observed in past (15).
In one study, EMG sessions produced a greater percentage of time in theta/alpha crossover states than alpha training alone, but the differences were small. All training sessions were associated with similar amounts of average theta/alpha ratio and percentage of theta/alpha crossover across sessions (13).
An attempt was made to address the methodological limitations of previous research work. Nonetheless, the present study contains 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.

These findings have also provided a stimulus for incorporation of these relaxation trainings as an effective method to reduce the sports related pre-competitive anxiety, test anxiety and task related stress.

Conclusion

From the present study, it can be concluded that biofeedback training can be effectively used as a part of multimodal treatment approach of GAD as defined by DSM IV-TR criteria.

Reference

1. Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshleman S, et al. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. Results from the National Comorbidity Survey. *Arch Gen Psychiatry* 1994; 51: 8-19.

2. Allgulander C, Bandelow B, Hollander E, Montgomery SA, Nutt DJ, Okasha A, et al. WCA recommendations for the long-term treatment of generalized anxiety disorder. *CNS Spectr* 2003; 8: 53-61.

3. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental disorders, 4th ed. text rev.* . Washington, DC: American Psychiatric Association; 2000.

4. Culpepper L. Generalized Anxiety Disorder in Primary Care: Emerging Issues in Management and Treatment. *J Clin Psychiatry* 2002; 63: 35-42.

5. Gorman JM. Treating generalized anxiety disorder. *J Clin Psychiatry* 2003; 64 Suppl 2: 24-29.

6. Townsend RE, House JF, Addario D. A comparison of biofeedback-mediated relaxation and group therapy in the treatment of chronic anxiety. *Am J Psychiatry* 1975; 132: 598-601.

7. Canter A. A comparison of EMG feedback and progressive muscle relaxation training in anxiety neurosis. *Br J Psychiatry* 1975; 127: 470-477.

8. Hammond DC. Neurofeedback with anxiety and affective disorders. *Child Adolesc Psychiatr Clin N Am* 2005; 14: 105-123.

9. Raskin M, Bali LR, Peeke HV. Muscle biofeedback and transcendental meditation. A controlled evaluation of efficacy in the treatment of chronic anxiety. *Arch Gen Psychiatry* 1980; 37: 93-97.

10. Hardt JV, Kamiya J. Anxiety change through electroencephalographic alpha feedback seen only in high anxiety subjects. *Science* 1978; 201: 79-81.

11. Moore NC. A review of EEG biofeedback treatment of anxiety disorders. *Clin Electroencephalogr* 2000; 31: 1-6.

12. Yucha C, Gilbert C. *Evidence-Based Practice in Biofeedback and Neurofeedback*. Wheat Ridge, CD: AAPB; 2004.

13. Moore JP, Trudeau DL, Thuras PD, Rubin Y, Stockley H, Dimond T. Comparison of Alpha-Theta, Alpha and EMG Neurofeedback in the Production of Alpha-Theta Crossover and the Occurrence of Visualizations. *Journal of Neurotherapy* 2000; 4: 29-42.

14. Rice KM, Blanchard EB, Purcell M. Biofeedback treatments of generalized anxiety disorder: preliminary results. *Biofeedback Self Regul* 1993; 18: 93-105.

15. DeGood DE, Chisholm RC. Multiple Response Comparison of Parietal EEG and Frontalis EMG Biofeedback. *Psychophysiology* 1977; 14: 258-265.

16. Lamontagne Y, Hand I, Annable L, Gagnon MA. Physiological and psychological effects of alpha and EMG feedback training with college drug users: a pilot study. *Can Psychiatr Assoc J* 1975; 20: 337-349.

17. Rice KM, Blanchard EB. Biofeedback in the treatment of anxiety disorders. *Clin Psychol Rev* 1982; 2: 557-577.

18. Garrett BL, Silver MP. The use of EMG and alpha biofeedback to relieve test anxiety in college students. In: Wickramasekera, eds. *Biofeedback, behaviour therapy and Hypnosis*. Chicago, IL: Nelson – Hall; 1976.

19. Sittenfeld P, Budzynski T, Stoyva J. Differential shaping of EEG theta rhythms. *Appl Psychophysiol Biofeedback* 1976; 1: 31-46.

20. Khanna A, Paul M, Sandhu JS. Efficacy of two relaxation techniques in reducing pulse rate among highly stressed females. *Calicut Medical Journal* 2007; 5: 2-7.

21. Jacobson E. *Progressive Relaxation (2nd Ed)*. Chicago: University of Chicago Press; 1983.

22. Sahni SP. *Psychology and its application in Sports*. India, New Delhi: DVS Publications; 2005.

23. Spielberger CD, Gorsuch RL, Lushene RE. *STAI manual for the State-trait anxiety inventory (" self-evaluation questionnaire")*. Palo Alto, CA: Consulting Psychologists Press; 1970.

24. Singh V, Sahni S. An effect of Progressive Muscle Relaxation training on heart rate and electrodermal response variables of boxers. *Sports Traumatology and Allied Sports Sciences* 2000; 2: 26-30.

25. Ossebaard HC. Stress reduction by technology? An experimental study into the effects of brainmachines on burnout and state anxiety. *Appl Psychophysiol Biofeedback* 2000; 25: 93-101.

26. Wenck LS, Leu PW, D'Amato RC. Evaluating the efficacy of a biofeedback intervention to reduce children's anxiety. *J Clin Psychol* 1996; 52: 469-473.

27. Sarkar P, Rathee SP, Neera N. Comparative efficacy of pharmacotherapy and bio-feedback among cases of generalised anxiety disorder. *Journal of Projective Psychology and Mental Health* 1999; 6: 69-77.

28. Vanathy S, Sharma P, Kumar KB. The Efficacy of Alpha and Theta Neurofeedback Training in

Treatment of Generalized Anxiety Disorder. *Indian J Clin Psychol* 1998; 25: 136-143.

29. Hidalgo RB, Davidson JRT. Generalized Anxiety Disorder An Important Clinical Concern. *Med Clin North Am* 2001; 85: 691-710.