Comparative Study Between Auditory, Visual and Combined EMG Biofeedback in Management of Patients with Tension type Headache

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ABSTRACT

Background : Tension-type headache (TTH) is the commonest primary headache.Electromyography (EMG) biofeedback (BF) is considered an effective therapy for tension-type headaches.Comparative effects of auditory and visual EMG biofeedback have not been systematically studied in TTH.The objective of the present study was to compare the effects of EMG BF with audio, visual and integrated BF on headache and quality-of-life in subjects with TTH.

Methods: Subjects with TTH fulfilling the International Headache Society criteria were selected by random sampling and allocated into EMG audio feedback (EMG-a),visual feedback (EMG-v) and integrated audiovisual feedback (EMG-av) groups.They underwent EMG BF therapy for fifteen sessions of thirty minutes each.The headache (pain) variables and SF-36(Quality of life) scores were documented at baseline, one month and three months after commencement of EMG BF therapy.

Results: All groups showed significant improvements in all pain variables.Improvements were also seen in the total,physical and mental scores of SF-36 scores in first and third month follow-up ($p<0.05$). Inter-group analysis revealed significant differences between the three groups ($p<0.05$) with EMG audio-visual BF showing more significant improvement in the pain variables.EMG-av BF group also showed highest improvement in SF-36 scores at first and third month follow up.EMG audio group showed significant improvement in the intensity parameter of pain variable at the third month follow-up.

Conclusion: Auditory, visual and integrated auditory-visual EMG biofeedbacks are effective in treatment of TTH with most benefit seen with combined feedback.

Key words: *Tension Type Headache, EMG Biofeedback, Audio Biofeedback, Visual Biofeedback, SF-36.*

INTRODUCTION

Tension type headache (TTH) is the most common type of primary headaches[1]. Biofeedback (BF), a process whereby information about usually unconscious biological activities is made available to consciousness is an established treatment modality for TTH[2]. BF treatments for pain emphasize the patients' active role in managing these conditions, thereby establishing improved coping with the psychological and psychosocial consequences of pain. BF is virtually free of untoward side effects and if effective for preventive and abortive treatment of headaches would obviously be preferable to the use of medication[3]. Though various forms of BF have been used in migraine, tension type headaches and combined headaches, electromyographic (EMG) BF has shown maximum benefits[4].

Muscle hardness has been found to be increased in the pericranial muscles of the patients with TTH[5]. It has been widely accepted that increased pericranial muscle activity is of important for the development of TTH as reflected in the formerly used term muscle contraction headache[6-8]. EMG BF is directed at reducing pericranial muscle activity and is the most frequently used behavioral treatment option for TTH[9]. McCrory et al reported medium-to-large average effects for EMG-BF in adults with TTH[10]. EMG BF units provide visual, auditory or both feedbacks. To our knowledge no study has been done so far to find out the effectiveness of auditory, visual or integrated (audio-visual) EMG feedback in TTH patients.

In a study, auditory EMG BF was used in TTH patients and it was found that the subjects were not only able to maintain low frontalis EMG levels but also managed to remain headache free during follow-up[11]. Similar studies utilizing only auditory BF have been performed in both TTH and migraine patients[6,12-14]. Visual EMG BF has been used less compared to auditory feedback[15]. In another study, TTH patients received both visual and audio EMG feedback and found significant decrease in headache[3].

Though there is evidence pointing out the efficacy of BF in tension headache patients, it is not advocated very frequently in India which could due to the cost of the equipment involved and hence the added cost to the patient as well. Most BF equipment provide both visual and audio feedback, hence if the equipment could be designed to provide only the form of feedback which is the most effective, it could automatically reduce the equipment cost as well as the cost to the patient making it more economical for both practitioner as well as patient.

No controlled trials have been done so far to compare the efficacy of visual EMG feedback or auditory EMG BF separately in tension type headache. This study therefore was conducted to find out relative efficacy of visual and auditory BF in isolation or combination in TTH subjects.

MATERIAL AND METHODS

Subjects fulfilling the International Headache Society (IHS) criteria for TTH were recruited in the study after obtaining informed voluntary consent. Both males and females were included in the study. Subjects were recruited from various neurology clinics and subjects referred by neurologists to our physiotherapy department for biofeedback therapy. Ethical clearance was obtained from the institutional ethical committee. A total of 30 TTH subjects were recruited by simple random sampling method and were allocated to various groups using the lottery method. Demographic data on pain variables namely average duration, frequency and intensity of headache per week were obtained. Quality-of-life score was obtained using the licensed SF-36 questionnaire at baseline, after one and three months of EMG BF therapy.

PROCEDURE

The subjects were explained the treatment procedure in detail.The subjects were made to lie with head end slightly higher to visualize the visual display in the EMG-v group. The same position was maintained for all groups to avoid any bias due to positioning. After preparing the forehead skin, surface EMG electrodes were applied 2.5cm above the centre of each eyebrow[6]. All subjects received BF for duration of 30 minutes per session for 15 sessions with eyes open. The EMG BF was performed using EMG-IR Retrainer, Chattanooga group Inc, U.S.A.

The EMG-a group (n=10) received auditory BF with headphones. The pitch of the sound was directly proportional to the relative muscle tension displayed on the screen. The subjects were instructed to reduce the pitch and intensity of the sound.

The EMG-v group (n=10) received visual feedback in form of glowing bars and numerical display,which increased or decreased depending on the muscle tension in bilateral frontalis (right and left separately). The auditory feedback was switched off for this group. The subjects were instructed to reduce the number of glowing bars or the numerical score.

The EMG-av group (n=10) received combined auditory and visual feedback.

After the end of 15 sessions the patients were instructed to relax similarly off sessions,whenever the headache started. They were also instructed to avoid taking any medication unless the headache was unbearable. Complete data on medication usage before and after therapy could not be obtained hence that data was not analyzed in this study.

All subjects were given diaries in which they had to note the pain variables at the end of every week. They were instructed to calculate frequency of headache as number of headache episodes per week, average duration as total hours of all episodes of headache that week divided by the number of episodes experienced in that week and intensity of headache as average of the visual analogue score (VAS) on a standard 10 point scale scored per headache that week. The average scores of the pain variables were recorded at baseline, one month and three months after receiving BF.

Statistical analysis was performed using the SPSS-16 version.

RESULTS

Thirty subjects were recruited in the study (females-18, males-12). Of the thirty subjects, seven subjects dropped out of the study. Three subjects failed to report for the first month follow up [EMG-a(1), EMG-av(2)] and four for the third month follow up [EMG-a(2),

EMG-v(1), EMG-av(1)]. All subjects however completed the 15 sessions of therapy. Therefore at the end of one month the sample size was: EMG-a: n=9, EMG-v: n=10 and EMG-av: n=8 and at the end of three months,it was: EMG-a:n=7, EMG-v: n=9 and EMG-av:n=7. No analysis was carried out for the missed data since it accounted for less than 20% of the sample size.

The three groups were matched relative to age and pain variables and SF-36 total scores (Table 1). The inter group analysis revealed non- significant differences between the groups in all variables,therefore the groups could be treated as homogeneous groups. Kruskall Wallis test was used to compare the groups for age and baseline parameters.

Table 1. Baseline data of the subjects

Sl. No.	Demographic variables	EMG-a	EMG-v	EMG-av	P-value
1	Age	42.3 ± 9.8	39.7 ± 15.1	43.5 ± 11	0.07
2	Average duration of headache/week	11.3 ± 5	10.8 ± 6	10.7 ± 6	0.14
3	Average frequency of headache/week	5.4 ± 1.6	5.2 ± 1.5	4 ± 1.5	0.13
4	Average intensity of headache/week	5.7 ± 2.1	5.2 ± 1.5	4.3 ± 1.3	0.15
5	SF-36 baseline total scores	42.0 ± 10.0	45.0± 10	43.0± 11	0.65

Mean of SF-36 scores and pain variables in all groups,at all end points in the study namely baseline,after one month and after months are depicted in the figures 1 and 2.

Bl-Baseline, 1m-after one month, 3m-after three months

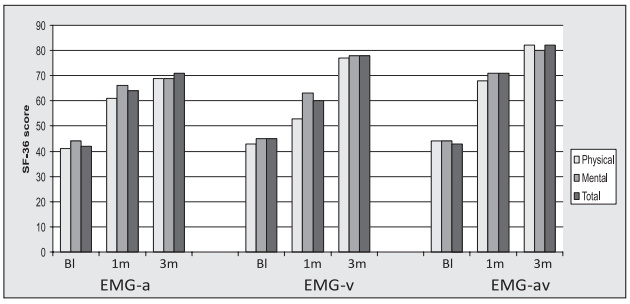

Fig. 1. Mean of SF-36 score in all groups

Bl-Baseline,1m-after one month,3m-after three months

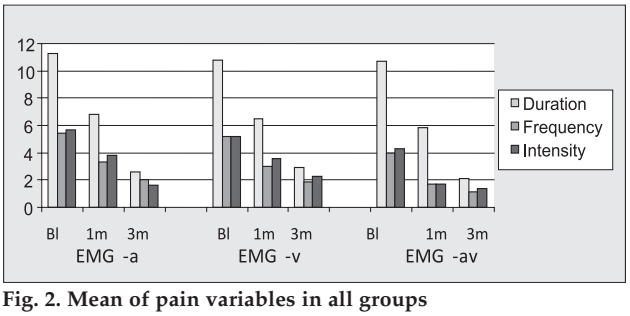

Fig. 2. Mean of pain variables in all groups

Wilcoxon matched pairs test was used for analysis of data obtained (pain variables and SF-36) for comparison within the groups. A non-parametric test was considered since the sample size per group was small. The analysis showed a highly significant reduction in all pain variables and SF-36 scores ($p<0.05$) after one and three months (Table 2), except in the groups which received only audio and visual feedback showing insignificant differences in average duration and frequency in the first month follow up. All groups showed significant improvement in all variables at six months follow-up.

Table 2. Intra-group analysis (p-value) using Wilcoxon matched pairs test

Variables	Groups	Baseline vs 1month	1 month vs 3 months	Baseline vs 3 months
Average duration of headache/ week (hrs)	EMG-a	0.006*	0.007*	0.005*
	EMG-v	0.02*	0.01*	0.005*
	EMG-av	0.007*	0.007*	0.005*
Average frequency of headache/ week	EMG-a	0.005*	0.2	0.005*
	EMG-v	0.04*	0.1	0.01*
	EMG-av	0.008*	0.008*	0.006*
Average intensity of headache/ week (VAS)	EMG-a	0.01*	0.07	0.005*
	EMG-v	0.05*	0.2	0.008*
	EMG-av	0.005*	0.044*	0.005*
SF-36 Total score	EMG-a	0.008*	0.03*	0.01*
	EMG-v	0.008*	0.04*	0.007*
	EMG-av	0.008*	0.05*	0.008*
SF-36 Physical score	EMG-a	0.008*	0.031*	0.008*
	EMG-v	0.047*	0.008*	0.008*
	EMG-av	0.016*	0.008*	0.008*
SF-36 Mental score	EMG-a	0.008*	0.047*	0.008*
	EMG-v	0.008*	0.016*	0.008*
	EMG-av	0.008*	0.008*	0.008*

*significant

Inter-group comparison was done using the Kruskall Wallis test(Table 3). All parameters showed significant differences in the intra group analysis.

Table 3. Inter-group analysis

		EMG-a	EMG-v	EMG-av	Kruskall Wallis test p value
Headache Duration	Baseline	11.3 ± 5.5	10.8 ± 6.6	10.7 ± 6.7	0.14
	1 month	6.8 ± 4.3	6.5 ± 4.7	5.8 ± 3.7	0.002
	3 months	2.6 ± 1.6	2.9 ± 3.0	2.1 ± 2.4	0.001
Headache Frequency	Baseline	5.4 ± 1.6	5.2 ± 1.5	4.0 ± 1.5	0.13
	1 month	3.3 ± 1.9	3.0 ± 1.1	1.7 ± 1.4	0.000
	3 months	2.0 ± 1.0	1.9 ± 2.2	1.1 ± 0.8	0.000
Headache Intensity	Baseline	5.7 ± 2.1	5.2 ± 1.5	4.3 ± 1.3	0.15
	1 month	3.8 ± 1.9	3.6 ± 2.1	1.7 ± 1.4	0.000
	3 months	1.6 ± 1.5	2.3 ± 1.6	1.4 ± 1.0	0.001
SF-36 total	Baseline	42± 10	45 ± 10	43 ± 11	0.65
	1 month	64 ± 9	60 ± 10	78 ± 7	0.001
	3 months	71 ± 9	71 ± 10	82 ± 7	0.000
SF-36 Physical	Baseline	41± 10	43 ± 7	44 ± 10	0.33
	1 month	61 ± 8	53 ± 11	77 ± 9	0.001
	3 months	69 ± 9	68 ± 8	82 ± 8	0.000
SF-36 Mental	Baseline	44 ± 8	45 ± 8	44 ± 9	0.17
	1 month	66 ± 11	63 ± 9	78 ± 9	0.001
	3 months	69 ± 15	71 ± 11	80 ± 6	0.000

All pain variables showed a highly significant difference between the groups after one month ($p<0.005$). Analysis of average intensity of headache per week showed that EMG-av had the lowest mean rank (EMG-a: 19, EMG-v:18, EMG-av: 9.5) indicating

that group EMG-av showed maximum benefit in the first month as compared to other two groups, however at three month follow up EMG-a group had the lowest mean rank as compared to other groups.

The variable average frequency of headache per week had EMG-av scoring the lowest mean rank at the first and third month follow up.

Average duration of headache per week too showed EMG-av with the lowest rank as compared to the other groups at the first month and third month.

SF-36 total, physical and mental scores too showed the best improvement in EMG-av group at one month and three month follow up with highest mean ranking compared to the audio or visual BF group.

DISCUSSION

Learning is facilitated when auditory and visual information is provided simultaneously, which explains why audio-visual aids are an integral part of learning.Likewise BF too is a learning process which therefore can be assumed to be facilitated by providing audio and visual cues to the patients.In our study there was significant improvement of headache variables and SF-36 sum and sub-scores in EMG-av group indicating that integrated feedback is more effective than isolated feedback.

In a similar non-therapeutic study,audio,visual and integrated (auditory plus visual) BF was given to participants and task performance like putting peg in a hole and electronic box assembly task was assessed for task completion time, performance errors and subjective opinions. The results showed that integrated feedback offered better assembly task performance than either feedback used in isolation.16This study indicates that adequate learning and retention (memory) requires input from both auditory as well as visual sources.

Another study similar to ours in terms of methodology, in which EMG BF was used for relaxation training.In this study the subjects were randomly assigned to four groups:1) group receiving EMG audio BF with eyes closed, 2) group receiving EMG audio BF with eyes open, 3) group receiving EMG visual BF and4)control group which received no feedback. It was reported that group which received EMG audio BF with eyes closed showed better decrease in frontalis muscle activity as compared to other groups. 17 However, integrated feedback was not used in this study.

Pain variables were difficult to compute in our study especially intensity, since it was variable through out the duration of headache. Hence to minimize the bias the patients were instructed to note the intensity at the peak of headache irrespective of intervention in the form of relaxation or medication. Number of headaches during the therapy was not analyzed,but there was a general trend of decrease in the frequency of headaches during the BF sessions in all groups irrespective of whether they received audio,visual or integrated EMG BF. One confounder we noticed in the study was the fluctuations in the auditory tone and visual bars on the display of the EMG equipment whenever the patient blinked causing a transient increase in the audio tone and increase in number of bars which may have caused confusion and distraction to the patient and therefore could have affected learning. The regional language (Kannada) version of SF-36 QOL questionnaire was used for all subjects who knew the language.The English version was used for subjects who could not understand the regional language to omit the bias created by translation of Kannada into English.

The inter-group analysis showed that EMG-av group had better benefits as compared to other groups and intra-group analysis too showed that EMG-av group had significant improvement over three months indicating that retention of improvement is good too. It was noted at several instances that inspite of specific instructions, some patients found it difficult in the initial sessions to concentrate on audio feedback in the EMG-a group. They used to either scan the room or looked distracted.This distraction may have affected our parameters too, since it would have affected the learning/ training which is provided by BF. On the contrary EMG-av group had better concentration as compared to other groups.Our brain processes visual and associated audio information as a natural habit in everyday life which is very essential for cognition, hence providing both feedbacks could have made information processing and modifying the biological processes (reducing frontalis activity) easier for the subjects. Moreover integrated feedback obviously gives additional information as compared to isolated feedback therefore understanding of the information is better and hence its modification too, which is the main aim of BF therapy.

The sample size in each group was small,hence studies with larger sample sizes should be considered in future. Though the groups were matched relative to age,pain variables and SF-36 scores ($p<0.05$), a better homogeneity could have been achieved if the subjects

were matched according to their baseline frontalis quantitative EMG activity.Another limitation of the study was the study duration.The duration of study too was small, considering the time factor involved in our study, hence longer duration longitudinal studies should be considered to study the efficacy of individual or integrated EMG BF and its retention of improvement with time. Since this is the first study of this nature,similar studies would definitely be required to confirm the efficacy of individual and integrated BF procedures in TTH as well as other psycho-somatic disorders where BF has proven effective.

CONCLUSION

All forms of EMG biofeedback are effective in treatment of TTH. Integrated EMG biofeedback is most beneficial in reduction of headache and improving quality of life in subjects with TTH.

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