

Electromyographic biofeedback-assisted relaxation training in juvenile episodic tension-type headache: clinical outcome at three-year follow-up

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Although tension-type headaches are more common than migraine in children and adolescents, the limited studies that have been conducted with juveniles have focused chiefly on migraine treatment and its course. This report describes the clinical benefits for an electromyographic biofeedback-assisted relaxation treatment program for a group of children and adolescents experiencing episodic tension-type headache and examines whether the clinical presentation changed for headaches that remained. Of the 54 consecutive juveniles who began treatment, 38 completed and were available to participate in the 3-year follow-up. Headaches improved measurably immediately following treatment, with further gains being evident through 3 years. The few headaches that did occur at 3 years were nearly identical symptom-for-symptom to those that were experienced prior to treatment. This report suggests that behavioural treatment is a viable and durable intervention for juvenile episodic tension-type headache, but more definitive claims cannot be made due to the uncontrolled nature of the study. Further investigation is warranted. □ *EMG biofeedback, relaxation training, tension-type headache, episodic, headache in children and adolescents, long-term follow-up*

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Headache is one of the most common disturbances in children and adolescents (1–12), and it is typically treated with medication or rest and reassurance. The potential for burdensome medication side-effects and emerging evidence supporting the short-term effectiveness of various behavioural treatments for paediatric headache (13–16), particularly migraine (16, 17), have led some to advocate that relaxation and biofeedback-based treatments be given primary consideration. Although the short-term data are encouraging, data attesting to the durability of behavioural treatment effects are more limited, and most of the available studies focus chiefly on migraine (18–24) or migraine grouped with other forms of headache (25–27).

Data concerning tension-type headache in children and adolescents may be found in various studies, but most of these studies have included a mixture of headache types and this can complicate interpretation.

Only a few of the extant investigations have addressed tension-type headache in isolation or have separated tension-type from other headache categories during data analysis. Several studies have shown relaxation training to be superior to placebo, symptom monitoring, and no-treatment in adolescents of varied ages (28–31). Investigators employing multicomponent treatment packages (31, 32) have produced significant effects that have held through varied follow-up periods.

The remaining studies have focused on chiefly biofeedback-based approaches. In the early 80 s, significant clinical improvement was reported for a single case of tension-type headache treated by frontal EMG BFB (33); effects endured through 1 year. Several years later, Grazzi et al. (13) evaluated the efficacy of EMG biofeedback treatment on a group of 10 paediatric patients suffering from tension-type headache alone. Significant clinical improvement was achieved and

maintained 1 year after the treatment. Finally, further support for the utility of a biofeedback-based approach is contained in Bussone et al. (34), who found EMG biofeedback-assisted relaxation to be superior to a pseudotherapy control procedure. Results held at 1 year.

Although the above-reported results are promising, all of the afore-mentioned studies contain certain limitations. In most investigations, patients included have suffered from different kinds of headaches and the diagnosis was not the same for all. This is an important aspect to consider because the evolution of migraine, particularly at a young age, may be different from the evolution of tension-type headache and migraine may change differently in females. For example, frequency of attacks can increase after puberty (3), tension-type headache may improve spontaneously (26), and sometimes the two forms of headache may shift from one to another (2). Further, the two forms of headache have different clinical characteristics, and they respond differently to different kinds of treatments. Finally, in the cited studies sample sizes have typically been small, follow-up data collection has been limited (minimal data have been collected for follow up exceeding one year), and even when samples have been restricted to tension-type headache, distinctions have not been made for episodic vs. chronic. This latter distinction has been shown to be important for research conducted with adults and would appear to be of prognostic value for juveniles as well (35).

In this report a group of children and adolescents suffering from tension-type headache were reexamined at various time points through three years after they had undergone a cycle of EMG BFB-assisted relaxation therapy in order to examine whether this treatment had long lasting benefits and also whether the clinical nature of any continuing headaches changed with time. Although this evaluation is uncontrolled, the relatively large number of juveniles suffering from discrete, episodic tension-type headache and the extended period of data collection (through three years) serve to make this a meaningful contribution to the existing literature.

Method

Participants

Our population consisted of 54 patients consecutively referred for treatment at the Headache Centre of the Neurological Institute 'C. Besta'. To qualify for entry into the study participants had to satisfy the International Headache Society Criteria (36) for episodic tension-type headache, to experience a minimum of one headache per week, to not have undergone a trial of preventive

pharmacological therapy previously, and to be absent of positive findings during neurological examination and routine laboratory tests. Use of nonprescription analgesics was permitted.

The initial population ($n=54$) consisted of 33 females and 21 males. The mean age was 12.1 years, with a range from 7 to 17 years. Mean age at headache onset was 9.3 years, with a mean duration of illness of headache of 2.8 years. Headache pain total index prior to treatment was 162.0, while the sample as a whole averaged 14.9 days of headache per month (see later section for descriptions of these pain measures). Although a number of the juveniles recorded 15 or more headaches during the 4-week baseline period, none of them met the IHS criteria for being labelled chronic (15 or more headache days per month for 6 or more months). Also, no participant revealed evidence of increased tenderness or EMG activity of pericranial muscles.

Six (11%) of the initial 54 participants (4 females and 2 males) ceased participation before treatment could be completed. Ten (18.5%) of the initial 54 participants (7 females and 3 males) were unavailable to provide follow up at the 3-year assessment. Mean age, age range, mean age at headache onset, mean duration of headache, pretreatment headache activity scores, and pretreatment days of headache per month for these 2 subgroupings combined (labelled 'noncompleters', $n=16$), along with comparable values for those patients who completed the 3-year follow-up ($n=38$) are presented in Table 1. *T*-tests for independent samples revealed no differences between completers and noncompleters for these pretreatment variables, which argues against sample bias due to attrition (juveniles who did not complete treatment or follow-up data collection and juveniles who did complete follow-up did not differ at baseline in terms of key demographic and headache severity variables).

Measures

Each patient maintained a daily headache diary for 4 consecutive weeks prior to treatment, throughout treatment, and for the 4 weeks immediately following completion of treatment. Diaries were again recorded for additional 4-week periods one and three years following treatment. Participants were asked to present for a clinical check up at each follow up evaluation. At this evaluation the characteristics of their headache syndrome (if any) were reassessed in order to determine whether the nature of the headache had changed and whether individual symptoms had improved or worsened.

The juvenile participants were instructed to record headache severity every hour on a 5-point scale, on which '0' indicated no headache and '4' indicated a very

Table 1 Demographic characteristics and initial pain scores for the participants

Participant grouping	n	Female	Male	Mean age	Age range	Mean age at headache onset	Mean duration of headache activity	Mean PTI at pre-treatment	Mean headache days per month at pre-treatment
Non-completers	16	11	5	12.7	7-16	9.1	3.6	173.8	17.1
Completers	38	22	16	11.8	8-17	9.4	2.5	157.1	14.1

intense headache (one that prevented work or play and necessitated confinement to bed). For each 4-week recording period a Pain Total Index (PTI) was calculated in accordance with the following formula, and this served as the primary measure of clinical outcome: [(no. of hours at level 1×1)+(no. of hours of level 2×2)+(no. of hours of level 3×3)+(no. of hours of level 4×4)]. In addition to this 'composite' measure, a second measure was determined in order to be consistent with IHS guidelines for conducting and evaluating pharmacological agents (35, 37). This consisted of the number of days with headache in a 4-week period.

Biofeedback instrumentation

A Satem biofeedback instrument (Myoexpand Series 400, EMG Module M3, connected by an Eizo 4050) was used for treatment and psychophysiological monitoring. After proper skin preparation, three circular metal Alpaca reusable cup type electrodes (2 cm in diameter; Seagull gel) were applied to the forehead (the reference electrode was centred directly over the bridge of the nose, while the active electrodes were centred directly over each eye) and secured with paper tape. The raw signal was rectified and averaged using a 100-ms time constant. The band pass was set to 100–1000 Hz. An IBM computer recorded and processed the information. The computer interface sampling rate was 20S/s; the computer averaged the signal over 10-second intervals with EMG values being recorded every second.

The operator adjusted the threshold of the auditory feedback signal provided to the patient from session to session depending on the level of muscular tension. The operator's task was to shape successively lower EMG levels; the subject's task was to go below threshold and turn off the auditory signal completely. With this procedure subjects learned to reduce their muscle tension progressively. The therapist was instructed to adopt an encouraging attitude initially but gradually to lessen involvement with subjects' relaxation exercises.

Procedure

Patients attended two sessions per week for a total of 10 sessions, with at least 2 days intervening between

any consecutive sessions. Patients were seated in comfortable recliners and were encouraged to close their eyes to enhance relaxation effects. The first four sessions were devoted to progressive muscle relaxation training, adapted from the approach of Bernstein and Borkovec (38), which focused primarily on relaxation exercises for eight muscle groups (lower arms, upper arms, legs, abdomen, chest, shoulders, eyes, and forehead). Each relaxation session lasted approximately 20 min. EMG BFB was introduced at the fifth session and this treatment remained the focus for the remaining sessions (6 in all). Each BFB session lasted 21 min and consisted of the following: 7 min baseline (for the purpose of setting the auditory signal threshold), 7 min of auditory feedback, and 7 min of self control (feedback signal turned off, while subject was instructed to continue attempting to relax). Subjects were instructed not to practice relaxation at home in order to provide a pure test of in-clinic treatment alone.

Follow-up

Follow up sessions were held 1, 3, 6, 9, 12, and 36 months after treatment completion. Patients were recontacted and asked to compile a headache diary for 4 consecutive weeks and then to present for a clinical check up. At these meetings the characteristics of their headache syndrome were reassessed in order to determine whether the nature of the headache had changed and whether the symptomatology had improved or worsened. At the follow-up sessions occurring at 1, 3, 6, 9, and 12 months post-treatment, subjects were provided a very brief ('refresher') course of therapy if requested. No further treatment was provided between the 12-month and 36-month follow-up.

Results

Headache measures

The PTI scores for completers were evaluated by a 2 (gender: female vs. male)×4 (period: pretreatment, 1-month, 1-year, vs. 3-year follow up) ANOVA. The period effect was highly significant: $F(3, 39)=31.76$,

$P < 0.0001$. Posthoc pairwise comparisons (least significant difference test) revealed that PTI scores were markedly reduced from pretreatment to 1-month post-treatment. Improvements were maintained at 1-year, with no statistical differences noted between 1-month and 1-year. However, the continued improvement revealed at 3-years was statistically significant from that in evidence at 1-month and 1-year. Thus, treated subjects continued to improve throughout the more extended follow up. Nearly all subjects revealed substantial improvement; 35 of 38 subjects (92%) revealed improvements equal to or greater than 60%. Thirty-two of 38 (84%) reported being symptom-free at the 3-year follow up. The main effect for gender was not significant: $F(1, 33) = 1.32, P = 0.26$. The interaction of gender and periods approached significance: $F(3, 99) = 1.77, P = 0.16$ (see Table 2).

Analysis for days of headache per month, conducted in an identical manner, revealed similar results: highly significant effect for period [$F(3, 84) = 42.33, P < 0.0001$]; significant effect for gender alone [$F(1, 28) = 5.42, P < 0.03$]; trend for significant effect for the interaction of period and gender [$F(3, 84) = 2.42, P = 0.07$] (see Table 2). Again, days of headache was markedly decreased from pretreatment to 1-month post-treatment, with little additional change at 1-year. However, the further reduction noted at 3-years was significant (when compared to the results at 1-year). This is most likely due to the continued improvement shown by the female patients, who had further room for improvement.

Finally, comparison of EMG values for the first treatment session (mean = 3.4 microvolts) to the final session of treatment (mean = 2.6 microvolts) revealed a significant decrease occurred [$F(1, 53) = 10.39, P = 0.002$], and that patients learned as intended during biofeedback-assisted relaxation. However, the percentage decrease in EMG activity was moderate (24%).

Headache characteristics

The patients did not show any change in the characteristics of their headaches (if present) and consequently for

all of them the diagnosis of episodic tension-type headache was reconfirmed according to the IHS criteria.

Discussion

This report suggests that biofeedback-assisted relaxation training is an effective long-term treatment for episodic tension-type headache in paediatric patients. Indeed, improvements continued through follow-up and even increased in magnitude at year 3. Further, only 16% reported some form of continued headache activity at three years. Treatment effects, it should be noted, endured in the absence of home practice. This is one of the few reports showing the utility of biofeedback-assisted relaxation in a population of paediatric patients suffering from pure tension-type headache. This is important because of the fact that different kinds of headache may be susceptible to different kinds of therapies.

Nevertheless, several limitations need to be acknowledged. The group of patients available at the last follow up was smaller than the group we had at the beginning of the treatment (38 patients vs. 54). Although completers and noncompleters were not found to be different on assessed variables, there may still have been some unmeasured differences that influenced outcome. For example, we did not systematically assess for other co-occurring factors that could have influenced the outcome, such as change in dietary habits or reductions in school and home stressors). Thus, it is possible that these and other unknown variables exerted some positive effect as well (25).

The most serious limitation is the absence of an untreated control group to evaluate extent of spontaneous remission. This simply was neither feasible nor desirable in the present clinical setting.

The final consideration relates to change in clinical diagnosis. The patients who were able to attend the last meeting, three years after treatment was completed, did not show any change in symptomatology when headache was still present. While overall pain report was markedly decreased, headaches that did occur resulted

Table 2 Mean pain total index and number of headache days per month (and standard deviations) for females and males, from pretreatment through 3-year follow-up

Gender	Pre-treatment	Post-treatment	1-year follow-up	3-year follow-up
Pain Total Index				
Females	178.6 (25.7)	61.5 (10.1)	44.9 (15.1)	2.1 (6.6)
Males	124.8 (28.0)	40.6 (11.0)	37.8 (16.4)	17.5 (7.2)
Number of headache days per month				
Females	16.4 (1.8)	7.1 (1.1)	6.5 (1.5)	0.3 (0.5)
Males	11.6 (2.1)	3.2 (1.3)	1.7 (1.7)	1.2 (0.6)

in the same symptoms, although dampened. That juvenile headache has a tendency to remit or change its nature with time is well known (2). In our report the character of the headache attack did not change, however, and initial diagnoses were reconfirmed. This may be due in part to the small number of patients or to the brief period of the follow up observation.

This report reinforces the effectiveness of a biofeedback-based approach for paediatric headache sufferers, even when placing minimal demands upon participants. The persistent positive changes, the absence of side-effects, and the good compliance with young patients leads us to recommend biofeedback-assisted relaxation training as a legitimate treatment alternative for ameliorating recurrent tension-type headaches in children and adolescents.

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