

*BIOFEEDBACK TREATMENT OF PARADOXICAL VOCAL  
FOLD MOTION AND RESPIRATORY DISTRESS IN  
AN ADOLESCENT GIRL*

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In this investigation, we evaluated the effectiveness of surface electromyography (EMG) biofeedback to treat paradoxical vocal fold motion in a 16-year-old girl. EMG biofeedback training occurred once per week over the course of 10 weeks. In a changing criterion design, muscle tension showed systematic changes that corresponded with changes in the criterion. Overall, baseline muscle tension levels were reduced over 60%, with corresponding reductions in episodes of respiratory distress and chest pain. Subjective reports by the patient and the patient's mother indicated improvements in school attendance and overall adaptive functioning.

DESCRIPTORS: biofeedback, behavioral pediatrics, health-related behavior, children, behavior modification

Biofeedback involves the application of operant conditioning to gain control of visceral, somatomotor, or central nervous system activities. Using biofeedback to modify apparently involuntary isolated muscle contractions represented a major early application of operant conditioning to covert activities (Shapiro & Surwit, 1979), and it continues to be an important avenue for the transfer of research-based behavioral technology into applied settings. For example, biofeedback has proven to be effective in the treatment of some vocal cord disorders. In dysphonias, excessive muscular contraction within the vocal tract leads to severe hoarseness, vocal fatigue, and even throat pain while speaking (Redenbaugh & Reich, 1989). Dysphonias can be difficult to treat but have responded to the use of biofeedback to teach

control of involuntary muscle activity during speech (Allen, Bernstein, & Chait, 1991; Watson, Allen, & Allen, 1993).

In contrast to the dysphonias, paradoxical vocal fold motion (PVFM) involves excessive muscle tension that causes the vocal folds to involuntarily adduct during inhalation rather than vocalization, restricting the airway opening. Patients with this type of covert muscle activity report chest pain, symptoms of labored breathing, harsh respiratory sounds, and feelings of being choked. Symptoms are often confused with and mistreated as asthma, at times resulting in emergency room visits and hospitalizations. Treatment of PVFM has typically focused on progressive muscle relaxation training or controlled breathing exercises in an indirect effort to relax the throat muscles (Mathers-Schmidt, 2001). Biofeedback, on the other hand, offers more direct impact and the possibility of differential control of excessive involuntary muscle activity. However, there are no reported applications of biofeedback to PVFM. The purpose of this investigation was to evaluate the effectiveness of electromyographic (EMG) biofeedback as a treatment of PVFM and to evaluate the impact of treatment on pain and adaptive functioning.

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## METHOD

### *Participant*

The participant was a 16-year-old Caucasian girl with a 2-year history of PVFM. Diagnosis was confirmed via visual inspection through a fiber-optic laryngoscopic exam by an otolaryngologist (Mathers-Schmidt, 2001). The participant reported daily chest pain, labored breathing, and feelings of being choked. She frequently missed school. Previous attempts at treatment over the past 12 months had involved controlled breathing exercises recommended by a speech therapist.

### *Dependent Measures*

*Electromyographic measures.* EMG data were collected via a computerized biofeedback system and visual monitor. Data were recorded in microvolts ( $\mu\text{V}$ ) and collected continuously throughout each of the biofeedback sessions. EMG surface electrodes were placed ipsilaterally and vertically in close, parallel alignment along the long axis of the thyrohyoid membrane, using the thyroid cartilage (i.e., the Adams apple) as an additional anatomical marker.

*Pain measures.* The participant recorded PVFM pain four times each day using a visual analogue scale ranging from 0 to 10, with 0 = *no pain*, 5 = *moderate pain*, and 10 = *severe pain*.

*Adaptive functioning.* The participant reported anecdotal evaluations of her adaptive functioning before and after treatment, and her mother completed a questionnaire rating pain interference (0 = *no interference* and 6 = *extreme interference*) with adaptive functioning in day-to-day activities (Allen & Shriver, 1998).

### *Experimental Design*

A changing criterion design was used. After determining baseline levels of muscle tension, treatment involved the use of EMG biofeedback until a lower muscle-tension criterion was met and stability at that level was achieved. At that point, a more stringent criterion was set, and

treatment was conducted until the new criterion level was met and stability at that level was achieved. Treatment continued until typical levels of muscle tension for that location near the vocal cords were achieved.

### *Procedure*

The participant attended a university-based clinic for biofeedback training on average once per week over the course of 10 weeks. During the initial pretreatment baseline, following a 10-min habituation period, EMG measures of muscle tension were recorded when no visual feedback was presented. Two sessions of pretreatment baseline data were collected before biofeedback treatment began.

During treatment sessions, each visit began with a 5-min resting baseline (i.e., no feedback), followed by two 10-min biofeedback sessions with a 5-min break between each session. During biofeedback sessions, the participant could view a visual representation of her muscle tension in the form of a moving vertical green bar. The preset criterion was represented by a stable dark horizontal bar. She was encouraged to try to relax and to lower her observed muscle tension below the preset criterion; this would change the vertical moving bar from green to red. No specific instructions were provided about how to accomplish this other than to watch the feedback. She was instructed to "try to relax the muscle tension near your vocal cords to below the criterion line on the computer screen, using the feedback to guide you." Average microvolts per session were calculated. The initial criterion level was set at 10  $\mu\text{V}$  (2  $\mu\text{V}$  lower than the average baseline levels). Subsequent criteria were determined according to the following set of rules: (a) A new criterion was set when the participant achieved three consecutive sessions at or below the current criterion. (b) Criterion goals were set 2  $\mu\text{V}$  lower than the previous criterion. (c) If two or more consecutive sessions were above the current criterion level, the criterion was raised 1  $\mu\text{V}$ . During the 5-min break, the participant

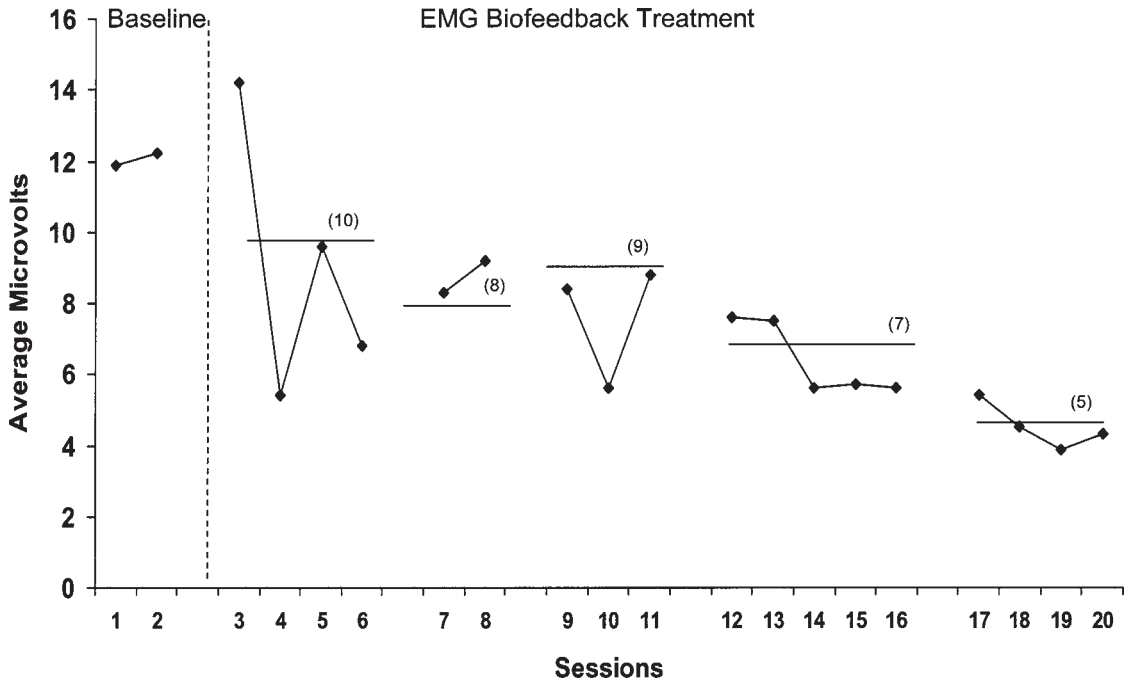


Figure 1. Average microvolts per session across baseline and treatment conditions. Horizontal lines and corresponding numbers in parentheses indicate changing criterion levels.

viewed a graph depicting her performance over the past 10 min in relation to the criterion goal.

## RESULTS AND DISCUSSION

EMG biofeedback was found to be an effective means of gaining control over muscle tension near the vocal cords. During EMG biofeedback, stepwise reductions in laryngeal muscle activity were observed with each criterion change (see Figure 1). In addition, wide variability in muscle tension was stabilized by the completion of treatment. Overall, baseline tension levels were reduced over 60%. Biofeedback treatment concluded when the participant demonstrated stability below the 5- $\mu$ V criterion level. To help determine an appropriate criterion for termination, normative baseline data were collected from five females ranging in age from 13 to 30 years with no history of asthma or vocal cord dysfunction. Normative data revealed an average laryngeal muscle

tension level of 5  $\mu$ V (range, 3 to 5  $\mu$ V). Thus, termination of biofeedback training occurred when the participant achieved a typical level of muscle tension.

There also were corresponding reductions in episodes of respiratory distress and chest pain. Daily pain ratings maintained by the participant during baseline showed that daily pain episodes with moderate to severe pain ratings (i.e., ratings of 4 or above) occurred 3 to 4 days per week. By the sixth biofeedback session, the participant reported zero pain episodes per week, and no pain or respiratory distress episodes were recorded thereafter. Most important for this participant was the improvement in adaptive functioning, as evidenced by an elimination of disorder-related school absences. Prior to biofeedback training, the participant reported missing 25% of all school days due to distress and pain associated with PVFM. Following the sixth session, no school absences due to PVFM symptoms were reported. At the

conclusion of treatment, the participant reported that she was pleased with the results of the biofeedback therapy and "happy to not miss any more school or extracurricular activities." Finally, the mother reported marked reductions in interference of daily functioning by PVFM symptoms from baseline (mean rating = 5) to treatment (mean rating = 0).

Although the experimental design permits reasonable conclusions about the effectiveness of EMG biofeedback in changing muscle tension in this individual, there are several factors that limit other conclusions that can be drawn from these data. For example, the generalizability of these results to other individuals with PVFM is unknown. In addition, the changes in adaptive functioning may reflect nonspecific effects derived from the intensive nature of services rather than anything unique to the biofeedback. Finally, the sample of women used for normative comparison was quite small, and their observed muscle-tension levels may not have been representative of typical tension levels in muscles near the vocal cords.

In spite of these limitations, this study suggests that EMG biofeedback can be an effective alternative to conventional relaxation therapies in the treatment of PVFM. It also demonstrates that the combination of sophisticated electronic technology and operant technology is powerful in teaching control over

covert behavior. By making subtle changes in muscle tension near the vocal cords more salient and by arranging for immediate and frequent reinforcement of changes in the desired direction, this participant was able to achieve clinically significant selective control of these covert responses.

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