A Meta-Analysis of EMG Biofeedback Treatment of Temporomandibular Disorders

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Portions of this study were presented at the 1998 annual meetings of the American Association for Dental Research and the Association for Applied Psychophysiology and Biofeedback.

Aims: *Outcome evaluations of treatments incorporating electromyographic (EMG) biofeedback for temporomandibular disorders (TMD) have been conducted for more than 2 decades. The purpose of this study was to review the available literature to determine the efficacy of biofeedback-based treatments and to estimate treatment effect sizes.* **Methods:** *A literature search located 13 studies of EMG biofeedback treatment for TMD, including 6 controlled, 4 comparative treatment, and 3 uncontrolled trials. Three types of outcome were examined: patient pain reports, clinical exam findings, and ratings of global improvement.* **Results:** *Five of the 6 controlled trials found EMG biofeedback treatments to be superior to no treatment or psychologic placebo controls for at least 1 of the 3 types of outcome. Data from 12 studies contributed to a meta-analysis that compared pre- to posttreatment effect sizes for EMG biofeedback treatments to effect sizes for control conditions. Mean effect sizes for both reported pain and clinical exam outcomes were substantially larger for biofeedback treatments than for control conditions. In addition, 69% of patients who received EMG biofeedback treatments were rated as symptom-free or significantly improved, compared with 35% of patients treated with a variety of placebo interventions. Follow-up outcomes for EMG biofeedback treatments showed no deterioration from posttreatment levels.* **Conclusion:** *Although limited in extent, the available data support the efficacy of EMG biofeedback treatments for TMD.*
J OROFAC PAIN 1999;13:29–37.

Key words: temporomandibular disorders, biofeedback, electromyographic treatment, meta-analysis

Temporomandibular disorders (TMD) are a heterogeneous group of problems characterized by orofacial pain and/or masticatory dysfunction.[1] Temporomandibular pain is typically located in the preauricular area, the muscles of mastication, or the temporomandibular joint (TMJ). However, patients may also report other facial pain, headache, and a variety of neck, shoulder, upper back, and lower back pains.[2] In addition, TMD patients may report a variety of jaw problems other than pain, including difficulty in maximal opening of the jaw, locking in the open or closed position, and clicking, popping, or grating sounds.

The symptoms presented by TMD patients can mimic a variety of disorders, and patients may seek care from several different providers, including otolaryngologists, internists, neurologists, chiropractors, and dentists. For example, 40% of TMD patients who

were referred to a tertiary dental care center had previously consulted a physician for the problem.[3] The varied symptomatology of TMD patients, resulting in consultations with several providers, may account in part for the significantly greater 2-year cost of treating TMD patients compared with patients without TMD.[4] Reduction of these costs will require the identification of standardized, cost-effective treatments for TMD.

Because the etiology of TMD is not well understood, the standard of care for TMD emphasizes conservative and reversible treatments such as patient education, medication, intraoral splints, and behavioral interventions.[5] Among the latter, electromyographic (EMG) biofeedback, relaxation training, and stress management counseling, either alone or in combination, have been used to treat TMD for more than 2 decades. Electromyographic biofeedback treatment of TMD was first described in 1975 in clinical reports by Carlsson et al[6] and by Gessel.[7] A 1987 review[8] of the small literature then available on the effectiveness of treatments that incorporated EMG biofeedback concluded that biofeedback approaches were "clearly promising" but lacked definitive experimental support because of the absence of appropriately designed outcome studies.

The current literature on TMD includes approximately a dozen outcome evaluations of EMG biofeedback–based treatment,[9] most of which were not included in the Mealiea and McGlynn review.[8] Although the number of outcome studies is relatively small, the results are sufficiently consistent to justify a status report at this time. The authors have therefore undertaken a quantitative assessment of this literature through the use of both conventional and meta-analytic techniques. The specific aims of this assessment were to determine: *(1)* the efficacy of EMG biofeedback–based treatment of TMD in comparison with appropriate control conditions; *(2)* the magnitude of treatment gains associated with biofeedback treatment; and *(3)* the degree to which treatment gains are maintained over time.

Materials and Methods

Study Identification

A literature search located 13 published outcome studies in which TMD patients who had been screened for or diagnosed with myofascial pain disorder were treated with some form of EMG biofeedback training. This number agrees closely with the 12 EMG biofeedback outcome studies located by Antczak-Bouckoms[9] in a bibliographic analysis of the literature on TMD therapy. The 13 studies reviewed here were identified through searches of bibliographies in the Mealiea and McGlynn review,[8] 2 recent commentaries,[1,10] and reprints in the authors' files. In addition, database searches of MEDLINE for 1966 to 1995 and PSYCHLIT for 1990 to 1997 were conducted by crossing the terms *temporomandibular* and *TMD* with *biofeedback*. The 13 studies identified included 6 controlled trials, in which EMG biofeedback treatment was compared with no treatment or a psychologic placebo[11–16]; 4 comparative trials, in which EMG biofeedback treatment was contrasted with an alternative therapy[17–20]; and 3 uncontrolled trials of EMG biofeedback treatment.[21–23]

Study Characteristics

For descriptive purposes, the EMG biofeedback condition of each trial was coded for the following procedural and patient variables:

- *Protocol:* EMG biofeedback training alone (BFB) versus EMG biofeedback training plus stress management (BFB+SM). BFB included EMG biofeedback training at a minimum but could also include instruction on the muscular etiology of temporomandibular discomfort and/or admonitions to recreate the sensations of low EMG activity during home practice. BFB+SM included additional individual or group counseling in stress management techniques and/or additional relaxation training, typically with taped home relaxation practice.
- *EMG site:* Facial muscle site(s) of surface EMG recording.
- *Sessions:* Number of treatment sessions.
- *Gender:* Percentage of females with the condition or, when unavailable, in the study sample.
- *Age:* Mean age of patients with the condition or in the study sample.
- *Previous treatment:* Percentage of patients with the condition or in the study sample who had failed to benefit from previous conservative treatment.
- *Number:* Number of patients.

Outcome Categories

EMG biofeedback trials typically reported information on 1 or more of 3 types of outcome:

- *Improvement:* Clinical judgment of global symptom amelioration following treatment. For present purposes, improvement required that the patient be categorized as either significantly improved, symptom-free, or requiring no further treatment.
- *Reported pain:* Measures of patient self-estimation of TMD-related pain such as daily ratings of pain intensity or pain frequency.
- *Clinical exam:* Measures derived from an examination of the TMJ and masticatory muscles. This category could include single measures of muscle palpation pain as well as combined measures of palpation pain and additional observations such as TMJ function, TMJ pain, and mandibular mobility. Measures of occlusal opening were infrequently reported and therefore did not figure in this analysis.

The distinction between reported pain and clinical exam outcomes is more operational than substantive in that both categories rely to varying degrees on patient reports of pain and discomfort.

Box Score Analysis

This analysis examined the efficacy of EMG biofeedback interventions for TMD by tallying the number and type of statistically significant outcomes reported in the 6 controlled trials that contrasted biofeedback treatment with either no treatment[13,15,16] or with a psychologic placebo control. A control condition was considered a psychologic placebo if it entailed a credible sham intervention or an intervention of unsubstantiated efficacy for TMD. The 3 placebo conditions were subthreshold transcutaneous electrical nerve stimulation (TENS) to the masseters,[12] bilateral ultrasound to the muscles of mastication,[11] and the application of dummy electrodes to the masseter coupled with a pseudo explanation of the relaxing effects of subthreshold electrical current.[14] Specific effects associated with any of the 3 placebo interventions would decrease the probability of identifying significant differences between them and EMG biofeedback treatment. The designation of an outcome as significant or not significant required a confirming statistical test or data that allowed for a post-hoc test of significance.

Meta-Analysis

Meta-analytic methods were used to estimate the magnitude of EMG biofeedback treatment effects for the 3 types of outcome. To include information from both controlled and uncontrolled trials, the authors examined pre- to posttreatment effect sizes within 12 EMG biofeedback treatment conditions that provided usable data. Within-treatment effect sizes provide information on the average degree of improvement to be expected with EMG biofeedback therapy. However, such effect sizes must be interpreted with caution because they combine both specific and nonspecific effects of treatment. To estimate the contribution of nonspecific effects to treatment outcomes, the authors also examined the pre- to posttreatment effects from several notreatment and placebo control conditions. This information was provided in part by the control arms of 5 EMG biofeedback trials. Additional information on the improvement of TMD patients with placebo was provided by 1 study of sham splint treatment,[24] 1 study of sham dental equilibration treatment,[25] and by the control condition of an intraoral splint outcome trial in which patients were issued a home relaxation tape without further training or monitoring.[26]

For each treatment or control condition that provided posttreatment ratings of global improvement, the percentage of patients who required no further treatment or who were rated as either significantly improved or symptom-free was calculated. For reported pain and clinical exam outcomes, standardized effect sizes for treatment and control conditions were calculated, when the requisite information was available. In several cases, the effect size for a measured outcome could not be calculated because the necessary data were not reported. When means and standard deviations were available or could be derived from raw data, the effect size was calculated as[27]:

$$ES = \frac{M_{pretreatment} - M_{posttreatment}}{SD_{pretreatment}}$$

Because of small sample sizes in several trials, the pretreatment standard deviations of all treatment and control conditions in a given trial were pooled when possible to obtain a more stable estimate of the population variance. When only *t*-tests and associated degrees of freedom were reported or could be derived from reported data, the treatment effect size was calculated as[28]:

$$ES = \frac{t}{\sqrt{df}}$$

Table 1 Characteristics of Studies Reviewed

Study	Treatment protocol	EMG site	No. of sessions	% female	Mean age	Received previous treatment (%)
Brooke and Stenn, 1983[11]	BFB+SM	Masseter	7	—	—	—
Burdette and Gale, 1988[21]	BFB+SM	Masseter	Ad hoc	88	44.7	—
Carlsson and Gale, 1977[22]	BFB	Masseter	Ad hoc	45	43.9	100
Crockett et al, 1986[12]	BFB+SM	Masseters	8	100	—	86
Dahlstrom and Carlsson, 1984[17]	BFB	Masseter	Ad hoc	100	28.6	0
Dahlstrom et al, 1984[23]	BFB	Masseter or frontalis	6	85	32.0	50
Dalen et al, 1986[13]	BFB	Masseter and frontalis	8	95	29.6	—
Dohrmann and Laskin, 1978[14]	BFB	Masseter	12	94	38.0	—
Funch and Gale, 1984[18]	BFB	Masseter	Ad hoc	—	43.0	100
Hijzen et al, 1986[15]	BFB	Masseter	10	94	—	0
Olson and Malow, 1987[19]	BFB vs BFB+SM	Masseter or frontalis	12	72	32.8	100
Stenn et al, 1979[20]	BFB+SM	Masseter	7	82	23.0	100
Turk et al, 1993[16]	BFB+SM	Masseters	6	82	34.1	—

BFB = biofeedback; SM = stress management; — = data not reported.

When a condition included more than one measure of an outcome, the mean effect size across measures was calculated.

Follow-up Analysis

Follow-up information was available for 8 of the 12 EMG biofeedback conditions that provided posttreatment data, as well as from 2 additional biofeedback trials that provided only follow-up information.[18,22] Percent improvement and effect size calculations were performed as described above, with the substitution of follow-up data for posttreatment data.

Results

Study Characteristics

As seen in Table 1, the 13 EMG biofeedback treatment trials were approximately evenly divided between those that employed biofeedback training alone as the active intervention and those that combined biofeedback training with stress management techniques. One trial contrasted biofeedback training with biofeedback plus stress management training. The majority of trials recorded masseter EMG activity either bilaterally or from the more affected side. Portions of the patients in 2 trials received frontalis EMG biofeedback only, while 1 trial combined masseter and frontalis feedback. Most trials provided a fixed number of biofeedback training sessions, varying between 6 and 12 weekly or semiweekly sessions; in 4 trials, the number of sessions was determined on an ad-hoc basis.

The percentage of female patients in the 13 trials ranged from 45% to 100%, with a mean of 85%. The mean patient age ranged from 23 to 44.7 years, with an overall mean of 35 years. The predominance of relatively young female patients is consistent with surveys of TMD patient populations.[3] Of the 8 trials that reported treatment histories, 50% or more of the patients in 6 trials had failed to improve with previous conservative treatment, including 4 trials in which all patients had failed to improve with previous treatment.

Box Score Analysis

Table 2 summarizes the results of the box score analysis of treatment efficacy. Five of the 6 controlled trials reported statistically significant differences between EMG biofeedback treatment and control conditions on at least one type of outcome. Both of 2 placebo-controlled trials found a higher proportion of patients markedly improved with EMG biofeedback than with a psychologic placebo. Four of 5 trials found EMG biofeedback superior to

Table 2 Significant Effects in Controlled Outcome Studies of EMG Biofeedback Treatment

Study (no. of subjects)	Control condition	Statistical significance		
		% improved	Reported pain	Exam
Brooke and Stenn, 1983[11] (E = 48, C = 48)	Placebo	Yes	—	—
Crockett et al, 1986[12] (E = 7, C = 7)	Placebo	—	Yes	No
Dalen et al, 1986[13] (E = 10, C = 9)	No treatment	—	No	—
Dohrmann and Laskin, 1978[14] (E = 16, C = 8)	Placebo	Yes	Yes	No
Hijzen et al, 1986[15] (E = 16, C = 16)	No treatment	—	Yes	Yes
Turk et al, 1993[16] (E = 30, C = 20)	No treatment	—	Yes	Yes

E = experimental subjects; C = control subjects; — = data not reported.

no treatment or to a psychologic placebo for reported pain outcomes, and 2 of 4 trials found EMG biofeedback superior to no treatment for clinical exam outcomes.

Meta-Analysis

Magnitudes of pre- to posttreatment effects for the 3 outcome categories are presented in Table 3, which organizes studies according to the type of EMG biofeedback treatment (with or without stress management) and the 2 different control conditions (no treatment or placebo). Mean effect magnitudes over biofeedback treatment conditions and over control conditions were weighted according to sample size.

The mean proportion of EMG biofeedback patients that met the improvement criteria (68.6%) was approximately twice that of placebo control patients (34.7%). When studies are used as the unit of analysis, the difference between the 2 means is significant: $t(9) = 2.27$, $P < 0.05$.

Similarly, effect sizes for both reported pain and clinical exam outcomes were substantially larger for EMG biofeedback treatment than for control conditions. For reported pain, the difference between the mean effect size for EMG biofeedback treatment (1.04) and the mean effect size for control conditions (0.47) approaches significance at $t(5) = 2.13$, $P < 0.10$. For clinical exam, the mean effect size for EMG biofeedback treatment (1.33) is significantly different than the mean effect size (0.26) for control conditions: $t(7) = 5.12$, $P < 0.01$.

On the assumption that reported pain and clinical exam outcomes are correlated indicators of temporomandibular impairment, treatment and control conditions were contrasted on the 2 outcomes combined. To weigh each treatment or control condition equally, the authors first found a mean effect size for those conditions that provided data on both outcomes. This yielded 7 effect sizes for biofeedback treatment (mean = 1.24, range = 1.08 to 1.89) and 4 effect sizes for control conditions (mean = 0.41, range = 0.19 to 1.00). There is no overlap in the 2 distributions, and the difference between the means is highly significant: $t(9) = 4.04$, $P < 0.01$.

Outcomes were similar for EMG biofeedback treatment trials that provided biofeedback training alone and trials that combined biofeedback with stress management. Among patients treated with EMG biofeedback alone, 65.4% met the improvement criteria, compared with 70.8% of patients who received biofeedback plus stress management. Considering the combined effect sizes for reported pain and clinical exam outcomes, the mean effect size for biofeedback training alone (1.23) was indistinguishable from that for biofeedback plus stress management (1.24). These results should be considered tentative because of the small number of trials that contributed to the comparisons. Similarly, attempts to correlate outcome differences among

Table 3 Pre- to Posttreatment Percent of Patients Improved and Effect Sizes for EMG Biofeedback and Control Conditions

Study	n	Type of outcome: % improved	Reported pain (ES)	Exam (ES)
EMG biofeedback treatment				
Biofeedback training				
Dahlstrom and Carlsson, 1984[17]	15	87	—	1.57
Dahlstrom et al, 1984[23]	20	55	—	1.14
Dalen et al, 1986[13]	10	—	1.09	—
Dohrmann and Laskin, 1978[14]	16	94	—	—
Hijzen et al, 1986[15]	16	—	1.05	1.30
Olson and Malow, 1987[19]	12	17	—	—
Biofeedback plus stress management				
Brooke and Stenn, 1983[11]	~48	64	—	—
Burdette and Gale, 1988[21]	37	78	—	—
Crockett et al, 1986[12]	7	—	1.64	1.26
Olson and Malow, 1987[19]	6	83	—	—
Stenn et al, 1979[21]	6	—	—	1.89
Turk et al, 1993[16]	30	—	0.89	1.27
Weighted mean (all treatment)		68.6	1.04	1.33
Control conditions				
No treatment				
Dalen et al, 1986[13]	9	—	1.00	—
Turk et al, 1993[16]	20	—	0.27	0.10
Placebo treatment				
Brooke and Stenn, 1983[11]	~48	35	—	—
Crockett et al, 1986[12]	7	—	0.42	0.73
Dohrmann and Laskin, 1978[14]	7	28	—	—
Greene and Laskin, 1972[24]	71	25*	—	—
Goodman et al, 1976[25]	25	64	—	—
Okeson et al, 1983[26]	12	—	—	0.27
Weighted mean (all control)		34.7	0.47	0.26

*Patient self-report.
ES = effect size; – = data not reported.

studies with differences in gender composition, mean age, and percentage of previously treated patients were not appropriate because of restricted sample sizes.

Follow-up

Total attrition for the 10 trials that reported follow-up data was an acceptable 17 of 193 patients (8.8%) over intervals ranging from 3 to 24 months (Table 4). Follow-up outcomes showed no deterioration from posttreatment levels. The mean proportion of patients who were significantly improved or symptom-free at follow-up (69.3%) was virtually identical to the posttreatment mean (68.6%). Four studies contributed 5 follow-up effect sizes for reported pain and/or clinical exam outcomes. In each case the effect size magnitude was larger at follow-up than at posttreatment, suggesting that EMG biofeedback patients at least maintain their improvement following treatment.

Discussion

Of the 6 randomized controlled trials conducted by different investigators, 5 provided evidence for the efficacy of EMG biofeedback treatment of TMD as compared to no treatment or placebo controls. The evidence is strongest for reported pain outcomes. The one failure[13] out of 5 trials to confirm the superiority of EMG biofeedback treatment on this outcome appears to be the result of an atypically large reduction of pain in the control group, rather than a failure of the active treatment (Table 3). Two of 4 trials failed to find significant

Table 4 Follow-up Percent of Patients Improved and Effect Sizes for EMG Biofeedback Treatment

Study	n (follow-up/ post-treatment)	Interval (mo)	Type of outcome		
			% improved	Reported pain (ES)	Exam (ES)
Brooke and Stenn, 1983[11]	~48/48	6	70	—	—
Carlsson and Gale, 1977[22]	11/11	4–15	73	—	—
Crockett et al, 1986[12]	7/7	3	86	—	—
Dahlstrom and Carlsson, 1984[17]	12/15	12	—	—	1.67
Dahlstrom et al, 1984[23]	15/20	6	—	—	1.37
Dalen et al, 1986[13]	10/10	5	—	1.55	—
Dohrmann and Laskin, 1978[14]	16/16	12	75	—	—
Funch and Gale, 1984[18]	26/30	24	54	—	—
Stenn et al, 1979[20]	5/6	3	100	—	—
Turk et al, 1993[16]	26/30	6	—	1.25	2.18
Total	176/193				
Weighted mean			69.3	1.33	1.84

ES = effect size; — = data not reported.

differences on clinical exam outcome measures, possibly because of very small sample sizes in one case[12] and the use of relatively insensitive categorical measures in the other.[14] The 2 trials that did find significant effects for clinical exam outcomes used appropriate sample sizes and relatively sensitive continuous measures.[15,16] Finally, both trials that reported on the percentage of patients who were markedly improved found EMG biofeedback treatment to be superior to a psychologic placebo.

We also estimated the magnitude of pre- to posttreatment outcomes with EMG biofeedback and compared these figures to similar estimates for no treatment and placebo conditions. Approximately 70% of patients required no further treatment, were symptom-free, or were substantially improved following EMG biofeedback treatment, compared with approximately 35% of patients given placebo treatments. A less stringent criterion for improvement would obviously increase the percentages in both treatment and control groups but would not necessarily affect the 2-fold superiority of EMG biofeedback. Electromyographic biofeedback treatment was also superior to no-treatment or placebo control conditions for reported pain and clinical exam outcomes. The pre- to posttreatment effect sizes for these 2 outcomes can be interpreted as percentile changes: for reported pain outcomes, the average EMG biofeedback patient moved from the 50th to the 85th percentile of patients who had not received treatment; for clinical exam outcomes, the average EMG biofeedback patient moved from the 50th to the 91st percentile of patients who had not received treatment. Follow-up evaluations showed that treatment gains for EMG biofeedback patients were at least maintained and may in fact have increased. Remarkably, these EMG biofeedback treatment results are based in part on several studies in which 50% or more of the patients had failed to improve with previous conservative treatment.

The mechanism or mechanisms underlying the apparent efficacy of EMG biofeedback for TMD are not well understood. The majority of studies reviewed here employed biofeedback to reduce EMG activity in facial and/or masticatory muscles. Biofeedback interventions aimed at reducing muscular activity assume that hyperactivity in these muscles accounts for TMD symptoms (particularly myofascial pain), that EMG biofeedback effectively reduces such activity, and that the reduction of muscular activity is responsible for the observed clinical improvement. The evidence in favor of these assumptions is mixed. Some studies have shown high baseline levels of EMG activity for TMD patients,[29–31] while others have not.[32] Similarly, some studies have found that TMD patients are more responsive to stressors in the facial and masticatory muscles than in other muscles or other physiologic response systems,[30,33] while other studies have not.[34] There is good evidence that EMG biofeedback reduces hyperac-

tivity in target muscles.[13,14,29] However, existing data, while limited, suggest that pre- to posttreatment changes in EMG activity are not correlated with the degree of clinical improvement.[21,23]

An alternative hypothesis holds that EMG biofeedback is effective because it enhances awareness of activity in facial and masticatory muscles, thereby improving patients' ability to detect, label, and voluntarily reduce muscle tension before it reaches uncomfortably high levels. This hypothesis is consistent with findings that TMD patients with myofascial pain show deficits in the proprioceptive awareness of the facial and masticatory muscles.[32,35,36] Successful discrimination and reduction of EMG activity in the masseter and temporalis muscles is typically accompanied by separation of the posterior teeth.[37] If patients acquire better awareness and control of these muscles and thereby keep the teeth separated, they may avoid low-level parafunctional activity that can, by itself, produce myofascial pain.[38,39]

According to a third hypothesis, EMG biofeedback is effective because it alters patients' perceptions of their degree of control over their symptoms.[15,20] In this view, success in learning to regulate EMG activity with biofeedback induces patients to adopt a more generalized belief in their ability to manage their own psychophysiologic states. This heightened self-efficacy in turn leads patients to initiate and persist in efforts to cope with the environmental stressors and the psychophysiologic reactions associated with TMD symptoms.[40] A treatment-induced increase in self-efficacy has also been advanced to explain the well-documented efficacy of EMG biofeedback treatment of tension-type headache.[41,42] A recent test of this hypothesis[40] reported that improvement in headache activity following EMG biofeedback was independent of changes in EMG levels but was related to patient reports of increased self-efficacy. Analogous investigations of biofeedback-induced alterations of patient cognitions have yet to be carried out with TMD patients.

The majority of EMG biofeedback treatment trials performed to date have employed sample sizes of fewer than 20 subjects per condition, which reduces statistical power and distorts estimates of outcome effect sizes. Nevertheless, there is substantial evidence for the efficacy of EMG biofeedback treatment (Table 2), and we see little need for further trials designed merely to illustrate the superiority of EMG biofeedback interventions over control conditions. On the other hand, there is a need for large-sample, controlled-outcome trials designed to estimate better the specific effects of EMG biofeedback treatment by the direct within-study comparison of biofeedback and control outcomes. The use of a standardized diagnostic protocol would eliminate variations in symptomatology that may have been present in the samples examined in this meta-analysis. Trials that compare EMG biofeedback to psychologic placebo and also standardize protocols with the use of treatment manuals would be particularly valuable.

In addition, research is needed on optimal protocols for EMG biofeedback treatment. Future research might examine the efficacy of EMG biofeedback training from multiple sites, analogous to suggestions that the treatment of tension-type headache is optimized with EMG biofeedback from multiple facial, pericranial, and neck muscle regions.[43] While our review found little evidence that combining stress management techniques with EMG biofeedback training is superior to biofeedback treatment alone, the only within-study comparison[19] of the 2 interventions did find an advantage for the combined treatment. Research on other treatment combinations is also indicated. For example, in 2 separate studies Turk and his associates showed that the combination of EMG biofeedback and intraoral splinting was more effective than either treatment alone[16] and that the addition of cognitive therapy to this combination was particularly effective for psychologically distressed TMD patients.[44] The possible synergies of EMG biofeedback treatment with other conservative interventions remains relatively unexplored.

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