Treatment of temporomandibular disorders among adolescents: a comparison between occlusal appliance, relaxation training, and brief information

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In a randomized trial the effects of occlusal appliance and relaxation therapy, each combined with brief information, were compared with brief information only, in adolescents with temporomandibular disorder (TMD) pain. One-hundred-and-twenty-two adolescents (93 F and 29 M aged 12–18 years) were randomly assigned to one of the following 3 groups: brief information + occlusal appliance (BI + OA), brief information + relaxation therapy (BI + RT), or brief information (BI). Included were subjects reporting pain once a week or more often, in addition to receiving a diagnosis of TMD according to the Research Diagnostic Criteria (RDC/TMD). They were evaluated before and after treatment and at a 6-month follow-up by means of self-reports and clinical assessment. The result revealed a significantly higher reduction in frequency of pain, in pain intensity (visual analog scale [VAS]), and in a composite pain index (intensity × frequency) for patients treated with BI + OA compared with those treated with BI alone. In the BI + OA group, 60% of the patients attained a clinically significant improvement (at least 50% or more) on the pain index, a significantly higher proportion compared to that obtained in the other 2 treatment groups. Analgesic consumption was also significantly more reduced in the BI + OA group compared to the BI group. However, no significant differences were found between the treatment groups in jaw opening or in muscle and TMJ tenderness scores. Occlusal appliance was found to be superior to both relaxation therapy and brief information regarding pain reduction and can therefore be recommended when treating adolescents with TMD pain. □ *Adolescents; occlusal appliance; randomized clinical trial; relaxation training; temporomandibular disorders*

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In epidemiological studies, the prevalence of temporomandibular disorder (TMD) pain (involving the masticatory muscles, the TMJ, and associated structures) among adolescents has been reported to range between 0.7% and 7% (1, 2). Various types of chronic pain can reduce psychosocial functioning and quality of life in children and adolescents (3). In a population-based study of adolescents with TMD pain, increased analgesic consumption and absence from school were reported, in addition to the majority reporting TMD pain once a week or more and requesting professional help (2). Previous studies have found that the majority of adolescents who receive TMD treatment experience good pain relief, but the studies are few and uncontrolled (4, 5). In a survey conducted in Sweden, general practice dentists reported that the most common forms of treatment provided for adolescents with TMD were information and occlusal appliance therapy (6). In a systematic review of the efficacy of occlusal appliance therapy, it was concluded that its use may be beneficial in the treatment of TMD. However, supporting empirical evidence is scarce (7). Various forms of behavioral therapies, e.g. biofeedback, relaxation training, and cognitive interventions, have been reported to be useful in the treatment of adults with TMD (8–10). However, in the majority of these studies, the effects of behavioral interventions in relieving pain have been found to be similar to conservative treatment of adults with TMD.

In epidemiological studies, tension-type headache (TTH) has been reported to be a prevalent pain symptom among adolescents with TMD (2, 11, 12). In several controlled school- and clinic-based studies, relaxation training has been found to be effective in reducing TTH among adolescents (13, 14). In recent reviews of chronic pain disorders among children and adolescents, it is concluded that relaxation is a well-established and efficacious treatment for recurrent migraine and TTH in children and adolescents (14, 15). It is likely that relaxation training might also be beneficial for adolescents suffering from other related recurrent pain conditions, such as TMD pain. To the best of our knowledge, no randomized clinical trial (RCT) has been conducted to evaluate the effects of treatment with occlusal appliance in comparative studies for adolescents with TMD pain.

The aims of the study were to evaluate the outcome of treatment by comparing occlusal appliance and relaxation

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training, each combined with brief information, as compared with brief information only, for adolescents with TMD pain, in addition to the maintenance of treatment effects at a 6-month follow-up evaluation.

Materials and methods

Subjects

One-hundred-and-twenty-two patients (93 F, 29 M) participated in the study. Ages ranged from 12 to 18 years, with a mean of 15.3 years. All adolescents were selected from a consecutive series of patients with pain and had been referred to the TMD clinic in Linköping, Sweden. The study was conducted in the period 1996 and 2000.

Inclusion and exclusion criteria

Patients were invited to participate in the study if they (1) reported pain once a week or more in the face, jaws, TMJs, or temples for a period of at least 3 months; (2) had received a TMD pain diagnosis according to the Research Diagnostic Criteria for TMD (RDC/TMD); and (3) wanted treatment. Exclusion criteria were juvenile rheumatoid arthritis, migraine, and current treatment with orthodontic appliances that could interfere with occlusal appliance treatment. The local Ethics Committee approved the study and all patients and parents signed an informed, written consent.

Design

The patients were randomly assigned to one of the following 3 treatment groups: brief information + relaxation training (BI + RT), brief information + occlusal appliance (BI + OA), or brief information (BI). All participants received identical brief information. The patients in the BI + RT and the BI + OA groups received treatment in 4 sessions conducted at 2-week intervals, whereas those in the BI group received information in one session. The patients were evaluated before treatment (Pre), after treatment, covering a 3-month period (Post), and at a follow-up 6 months after treatment (FU). At each evaluation, all subjects filled out a self-administered questionnaire and were clinically examined by a 'blinded', calibrated clinician (KW). In addition, subjects were asked to record daily experiences of pain in a diary at home. A dental nurse was available to answer questions if needed and to check the questionnaire for completeness and legibility. A previous study had established acceptable reliability for the questionnaire, the TMD examination, and the diagnosis in adolescents (16). A trained therapist administered the brief information and the relaxation therapy, and a dentist performed the occlusal appliance therapy.

Pain measures

In a questionnaire the adolescents assessed their intensity, frequency, and location of TMD-related pain, jaw function, parafunctional habits, jaw disability as well as medication. For a detailed description of these items and the reliability of the questionnaire, see Wahlund et al. (16). A short description of the various parameters included in the study is given below.

Pain intensity. The intensity of pain was reported on a 0–10 cm visual analog scale (VAS) with the endpoints 'no pain' and 'worst pain imaginable' (17).

Pain frequency. The frequency was reported on a 5-point scale: 'Never', '1–2 times a month', 'Once a week', 'Several times a week', or 'Daily'.

Pain index (PI). The main outcome measure, a composite pain index, was calculated on the basis of the reported pain intensity (VAS) multiplied by the frequency of pain (18). The scores ranged from 0 to 50.

Pain diary. The participants were also instructed to use a diary to record their TMD pain intensity and analgesic consumption 4 times daily: at 'Breakfast', 'Lunch', 'Dinner' (after school), and 'Bedtime'. The recordings were made for a 2-week period before and after treatment as well as at the 6-month follow-up. The pain intensity was rated on a 6-point behavior rating scale: 'No pain', 'Pain, I am only aware of it if I pay attention to it', 'Pain, but I can ignore it at times', 'Pain, I can't ignore it but I can do my usual activities', 'Pain, it's difficult to concentrate, I can only do easy activities', 'Pain, such that I can't do anything' (13, 19). Total weekly pain scores varied from 0 to 140.

Subjective evaluation of the treatment. This measure was composed of six response alternatives ('Completely well', 'Much better', 'Somewhat better', 'Unchanged', 'Somewhat worse', 'Much worse'). The adolescents were asked to choose the alternative that best described their experience of treatment outcome.

Clinical significance. In line with recommendations for headache (19), a reduction of 50% or more in the pain index was used to define a clinically relevant pain improvement based on changes between pre–post assessments. The proportion of adolescents who achieved such a level of improvement in each treatment group was calculated, and the patients were classified as responders (at least 50% pain reduction in the PI) and non-responders (less than 50% pain reduction in the PI).

Other pain-related measures

The following items were rated in the questionnaire.

Analgesic consumption. The subject's consumption of painkillers was rated on a 6-point scale: 'Daily', '3–4 times a week', '1–2 times a week', 'Once in a while', 'Every month', and 'Never or almost never' (20).

School absence. The number of days of absence from school during the previous month because of TMD pain was recorded.

Bruxism. Subjects were asked whether they grind or clench their teeth, and their responses were recorded as 'No' or 'Yes'.

Clinical examination

Research diagnostic criteria for temporomandibular disorders (RDC/TMD). The clinical examination assessed the following signs and symptoms among the adolescents: in the previous month the site of pain in the face, jaws TMJs, or temples; mandibular range of motion (mm) and associated pain (jaw-opening pattern; unassisted opening without pain; maximum unassisted opening; maximum assisted opening; mandibular excursive and protrusive movements); TMJ sounds (clicking, crepitating); muscle and joint palpation (lateral/posterior) for tenderness (21).

In addition, the participants underwent a neurologic examination of cranial nerve function, motor coordination, and balance.

Pressure pain threshold (PPT). A pressure algometer (Somedic, Sweden) was used to measure the pain threshold of pressure (PPT) stimuli applied on the skin surface over the TMJ and masticatory muscles. The mean of two successive measurements at the following three anatomic locations was used to determine the individual PPT: the anterior temporal muscle, the TMJ, and the masseter insertion. Acceptable intra- and inter-examiner reliability has been reported previously (16).

Classification

The RDC/TMD classifies the most common forms of TMD within the following 3 categories and allows multiple diagnoses to be made for a given patient: myofascial pain, disk displacements, and arthralgia, arthritis, and arthrosis (21). TTH was diagnosed according to the International Headache Society criteria (IHS) (22). A good reliability for the RDC/TMD diagnoses was found in a previous study (16).

Motivation and credibility

Before treatment, the adolescents were asked the following 4 questions on a 0–10 cm VAS scale: (1) 'How motivated are you to begin this treatment?' (end definitions 'Not at all' and 'Very much'); (2) 'How much time and work are you willing to put into this treatment?' (end definitions 'None' and 'Very much'); (3) 'How good do you think this treatment is for your pain in the face and temples?' (end definitions 'Not good at all' and 'Very good'), and (4) 'Would you recommend this treatment method to a friend who has the same type of pain as you have?' (end definitions 'Yes' and 'No').

Treatment

Relaxation training. The purpose of relaxation training was to teach the adolescents a rapid method to apply in everyday situations at times of increased bodily tension and pain. The patients in this group underwent 4 individual sessions of relaxation training. During these sessions, the patients were also informed about common stressors, stress management, and relaxation techniques. A home-training program, including a manual and taped instructions, was given to each patient. The importance of regular home practice, at least once a day for 15–20 min, was emphasized by the therapist. The relaxation training program has previously been evaluated in several controlled treatment studies of school adolescents with recurrent headaches (23).

Occlusal appliance. In this treatment group the adolescents were instructed to use the appliance every night until the evaluation directly after treatment and afterwards when they felt the need of using the appliance until the 6-month follow-up. The occlusal appliances were stabilization splints placed in the upper jaw. The splint surface was adjusted to provide a maximum occlusion and was constructed with canine guidance (24). The procedure was as follows: at the first visit, the patient was given information; at the second visit, an impression for the occlusal appliance was made; at the third visit, the occlusal appliance was given to the patient after adjustment; and at the fourth visit, the appliance was checked and readjusted.

Brief information. Brief information was provided to the participants individually during one session lasting about 30 min. The following areas were discussed: TMD-related anatomy, pain epidemiology, parafunction, and stress.

Compliance. After treatment and at the 6-month follow-up, subjects in the BI + OA group were asked to rate the following question on a 0 to 4 scale (0 = 'Never', 4 = 'Every night'): 'How often have you used your splint?' Subjects in the BI + RT group were asked the following question: 'How often did you practice rapid relaxation?' The frequency was rated on a 5-point scale from 0 ('Never') to 4 ('Daily').

Statistical methods

Associations between categorical variables were analyzed by means of the chi-square test. Differences between group means on continuous variables were analyzed with analyses of variance (ANOVAs) (pre–post gain scores); for ordinal variables, the Kruskal-Wallis test was used. If the overall result on the ANOVA was significant, subsequent Bonferroni post hoc comparisons were performed for continuous variables, and for ordinal variables post hoc procedures as described by Siegel & Castellan (25) were used.

Results

Pretreatment assessment

No significant differences in regard to number of patients, sex, age, dropouts, and distribution of diagnoses

Table 1. Distribution of the 122 adolescents with TMD pain (percentages in parentheses) in the 3 treatment groups by sex, age, dropout, and diagnoses. (BI + RT = Brief information + Relaxation Training, BI + OA = Brief Information + Occlusal Appliance, BI = Brief Information)

	Treatment group			
	BI + RT ($n = 41$)	BI + OA ($n = 42$)	BI ($n = 39$)	All ($n = 122$)
Sex				
Girls	35 (85%)	31 (74%)	27 (69%)	93 (76%)
Boys	6 (15%)	11 (26%)	12 (31%)	29 (24%)
Age				
Mean ± *s*	15.4 ± 2.0	15.7 ± 2.1	14.8 ± 1.9	
Dropout	7 (17%)	5 (12%)	0	12 (10%)
RDC/TMD				
Myofacial pain	37 (90%)	42 (100%)	37 (95%)	116 (95%)
Disc Displacement	6 (15%)	5 (12%)	5 (13%)	16 (13%)
Arthralgia, arthritis, arthrosis	10 (24%)	8 (19%)	6 (15%)	24 (20%)
IHS				
Episodic tension type headache	17 (41%)	17 (40%)	19 (49%)	53 (43%)
Chronic tension type headache	19 (46%)	23 (56%)	17 (43%)	59 (48%)

s = standard deviation.

were found between the three groups (Table 1). Multiple subdiagnoses encompassing more than one diagnostic group are possible with the RDC/TMD, but not according to the IHS criteria. Myofascial pain was the most common RDC/TMD diagnosis, ranging from 90% to 100% among the subjects in the 3 groups. The majority of the patients reported either episodic or chronic TTH ranging in frequency from 88% to 95% in the 3 groups.

The mean values of the credibility (BI + RT: 7.61; BI + OA: 8.33; BI: 7.76) and motivation ratings (BI + RT: 7.83; BI + OA: 7.80; BI: 7.50) before treatment differed non-significantly between the treatment groups. Thus, the adolescents in the 3 groups regarded the treatment methods as being equally credible, and motivation levels in all 3 groups were similar (Fig. 1).

Treatment completers and dropouts

Seven patients (17%) in the BI + RT group and 5 (12%) in the BI + OA group dropped out during the treatment period and were therefore not included in the statistical analysis. The reasons for dropping out were as follows: one patient had moved to another city and 11 reported that they did not have time or were not interested in continuing their participation in the study. There were no significant differences between dropouts and completers in the treatment groups according to sex and age. Although subjects who dropped out had lower pain scores and less motivation to participate in treatment, these differences were non-significant, except for one motivation item 'How much time are you willing to put into this treatment?', where the dropouts had significantly lower scores than the completers (M = 6.1 vs M = 7.5); t(117) = 2,16; $P < 0.05$). The analysis of assessment before treatment included all randomized patients, but only treatment completers were included in the outcome analyses below.

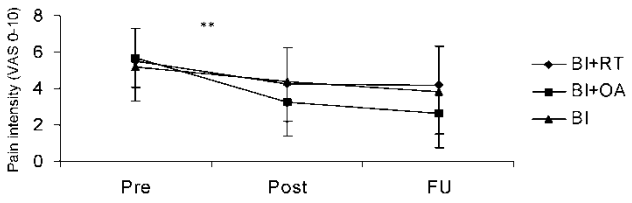

Fig. 1. Pain intensity (VAS). Means and standard deviations before treatment (Pre), after treatment (Post), and at the 6-month follow-up (FU) by treatment group (BI + RT = Brief Information + Relaxation Training, BI + OA = Brief Information + Occlusal Appliance, and BI = Brief Information). ** $P < 0.01$. Pre–post significant difference between the BI + OA and the BI groups.

Pain symptoms

Mean values and standard deviations for pain recordings in the diary (behavioral rating scale) before treatment were 29.8 ± 21.8 for the BI + OA group, 25.3 ± 20.2 for the BI + RT group, and 18.0 ± 13.5 for the BI group. No significant differences were found between the groups before treatment. Owing to fairly extensive missing data for the BI + OA group at post-treatment (38%) and at follow-up (40%), no statistical between-group analyses were made after treatment.

The mean values and standard deviations for the pain intensity scores (VAS) in the 3 treatments groups are shown in Fig. 1. No significant differences were found between the groups before treatment. A significant difference in pre–post gain scores between treatment groups was found [F(2,107) = 5.16; $P < 0.01$]. A subsequent post hoc test showed that adolescents treated with BI + OA were significantly ($P < 0.01$) more improved than those in the BI group but not significantly different from those in the BI + RT group. The effect size was 9% (eta^2).

The median values and quartiles for pain frequency before treatment, immediately after treatment, and at the 6-month follow-up are given in Table 2. Before treatment, a significantly higher frequency of pain was found for the

Table 2. Pain frequency, analgesic consumption (median [Md] and quartiles [q]), school absence, clinical variables (means and standard deviations [*s*]) before treatment (Pre), after treatment (Post), and at the 6-month follow-up (FU) by treatment group. (BI + RT = Brief Information + Relaxation Training, BI + OA = Brief Information + Occlusal Appliance, BI = Brief Information)

	Pre			Post			FU			
	BI + RT	BI + OA	BI	BI + RT	BI + OA	BI	BI + RT	BI + OA	BI	*P*
Pain frequency[a]										
Md	3	4	3	3	2	3	3	2	3	0.05*
q1–q3	3–4	3–4	3–4	2–3	2–3	2–4	2–3.25	2–2	2–4	
Analgesic consumption[a]										
Md	2	3	2	2	1	1	2	1.5	1	0.05*
q1-q3	1.75–3	1–3	1–3	1–2	1–2	1–2	1–2	1–2	1–2	
School absence[b]										
Mean	0.86	0.26	0.08	1.24	0.22	0.08	0.38	0.13	0.04	ns
±*s*	0.98	1.25	0.41	3.36	0.67	0.40	0.53	0.62	0.20	
Clinical variables										
PPT[c] (TMJ)										
Mean	159.7	148.2	136.9	156.0	164.7	148.3	179.6	158.4	161.3	ns
(±*s*)	55.1	60.5	50.8	52.7	51.5	53.8	59.2	39.3	61.1	
PPT[c] (muscle)										
Mean	304.5	291.1	287.3	341.6	334.0	295.0	366.8	344.5	335.0	ns
±*s*	109.6	113.2	97.8	101.6	100.3	99.3	119.7	100.7	94.3	
Maximum assisted mandibular opening without pain										
Mean	47.4	47.2	47.5	49.4	49.3	47.1	50.0	49.5	47.8	ns
±*s*	6.7	9.2	6.5	6.4	8.8	7.2	5.5	7.3	6.2	

[a] Scale (0–5).
[b] Scale (0–31).
[c] PPT = Pressure Pain Threshold.
* $P < 0.05$. Pre–post significant difference between the BI + OA and the BI groups.
s = standard deviation.

BI + OA group compared with the BI group ($P < 0.05$). The results of a Kruskal-Wallis test showed an overall significant pre–post difference between the treatment groups [χ^2 (2) = 8.15; $P < 0.05$]. Subsequent post hoc analyses showed that the frequency of pain was significantly reduced only for subjects in the BI + OA group compared with those in the BI group ($P < 0.05$).

The mean values and standard deviations of the composite pain index (intensity × frequency) are presented in Fig. 2. A significant difference between treatment groups in pre- and post-treatment gain scores was found [F(2,107) = 6.03; $P < 0.01$]. A subsequent post hoc test showed that adolescents treated with BI + OA improved significantly ($P < 0.01$) more than those in the BI group, but were not significantly different from those in the BI + RT group. The effect size was 10% (eta^2).

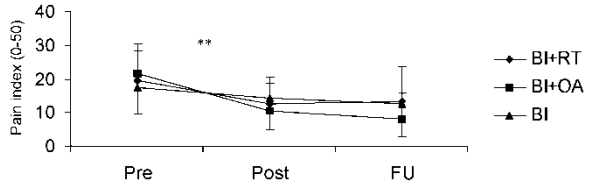

Fig. 2. Pain index (intensity × frequency). Means and standard deviations before treatment (Pre), after treatment (Post), and at the 6-month follow-up (FU) by treatment group (BI + RT = Brief Information + Relaxation Training, BI + OA = Brief Information + Occlusal Appliance, and BI = Brief Information). ** $P < 0.01$. Pre–post significant difference between the BI + OA and the BI groups.

Clinical significance

Sixty percent of the subjects in the BI + OA group, 32% in the BI + RT group, and 23% in the BI group obtained at least a 50% improvement on the PI. The results of the chi-squared analyses showed that these differences in proportions between treatment groups were significant [χ^2 (2) = 11.36; $P < 0.01$]. Subjects in the BI + OA group were significantly more improved compared with those in the BI + RT ($P < 0.05$) and the BI ($P < 0.001$) groups. Completers who experienced a subjective improvement had obtained a pre–post improvement rate ranging between 38% and 68% (mean value 53%) on the PI. For each treatment group, mean percentages of subjective improvement were as follows: BI + RT: 35%; BI + OA: 51%; BI: 26%.

Treatment compliance

At the post-treatment evaluation, 53% of the patients in the relaxation group reported that they were practicing relaxation in their daily life situation regularly. Seventy-eight percent of the patients treated with occlusal appliance therapy reported that they used the splint at least every second night. A positive correlation between the frequency of appliance usage and the improvement in

the PI was found ($r = 0.30$, $P = 0.07$) and also between the use of relaxation training and the improvement in the PI ($r = 0.20$, ns).

Follow-up evaluation

For all pain symptoms (pain intensity, pain frequency, and the PI), the results of further analysis of post-follow-up gain scores showed no significant differences between treatment groups, indicating that improvement was well maintained at the 6-month follow-up evaluation.

Bruxism

When the 3 treatment groups were pooled together, no significant association between clinically relevant pain improvement and bruxism was found, nor when the patients in the BI + OA group were analyzed separately.

Analgesic consumption and school absence

No significant differences were found between the treatment groups before treatment in any of the two variables (see Table 2). A significant difference was found between the treatment groups on the pre- and post-treatment gain scores for analgesic consumption [χ^2 (2) = 6.65; $P < 0.05$]. Post hoc analyses showed that consumption of analgesic was significantly more reduced in the BI + OA group than in the BI group ($P < 0.05$), but not for subjects in the BI + RT group. However, no significant differences in school absence between treatment groups in pre–post gain scores were found, nor were the differences in post-follow-up gain scores for analgesic consumption and school absence significant (see Table 2).

Clinical measures

No statistical differences between treatment groups before or in pre–post change scores on vertical ranges of motion mean values and standard deviations for unassisted opening without pain and PPTs were obtained (see Table 2). None of the patients in any of the treatment modes reported any major adverse effects.

Discussion

In the present controlled study we evaluated the effectiveness of occlusal appliance and relaxation therapy, each combined with brief information, and brief information only, in the treatment of TMD pain among adolescents. All the patients in this study wanted treatment and had been consecutively referred to the TMD unit in Linköping, which is responsible for all adolescents with TMD pain in this region of Sweden. The gender distribution of the participants, i.e. a preponderance of girls, was similar to rates reported in clinical as well as population-based studies of adolescents with TMD pain or recurrent headaches (1, 22). The majority of the patients exhibited myofascial pain, which is in line with findings in a previous study of adolescents with TMD pain (2). Thus, the sample included in the present study can be considered to be representative for Swedish adolescents with TMD pain. It should be noted that the overall pain levels recorded by the adolescents in their diaries (behavior rating scale) in our study were similar to those reported by adolescents suffering from recurrent TTH in previous intervention studies (13, 23). These findings suggest that TMD pain among adolescents in the present sample is a severe and clinically important problem. Overall, the dropout rate of 10% was low and comparable with rates reported in similar treatment studies of recurrent headaches among school adolescents (13). Completers and dropouts did not differ significantly in sex or age, but dropouts had lower motivation to participate in treatment, in addition to a lower pain severity.

It has been postulated that a patient's attitude towards an intervention method can have an important bearing on treatment adherence and cooperation (26). In the present study, credibility and motivation ratings were similar for subjects in all 3 groups before treatment. In a previous study of adolescents, an acceptable reliability was also found for the subjective and clinical measures used in this trial (16). Because pretreatment conditions for the 3 groups were similar, outcomes for subjects who completed treatment are likely to be a result of differences in treatment effectiveness between the 3 interventions. Overall, the results showed that occlusal appliance combined with brief information therapy was superior to the other 2 treatment methods in reducing both the intensity (VAS) and frequency of pain among the adolescents with TMD. To the best of our knowledge, this is the first controlled outcome study evaluating the effectiveness of an established treatment, i.e. occlusal appliance, for adolescents with TMD pain. Similar outcomes after treatment have also been found for occlusal appliance therapy in a study on adults with TMD (8). Reductions in the frequency of pain following relaxation treatment have been reported in previous studies of adolescents suffering from recurrent headaches (23, 27). Furthermore, differences between the treatment groups were found to be high in that the effect sizes for reduction of pain symptoms were 9–10% (28), thus indicating a high clinical relevance. A clinically meaningful measure of pain reduction commonly used is to estimate the proportion of subjects who attain a 50% pain reduction or more (19, 29). In line with these recommendations, a reduction of at least 50% on a TMD pain index, i.e. a composite intensity of pain and frequency, was used to assess a clinically meaningful pain reduction among adolescents. On this measure, about two-thirds of adolescents treated with occlusal appliance had attained a clinically significant improvement compared with 32–23% in the BI + RT and

BI treatment groups, respectively. Our findings for adolescents treated with relaxation contrast with results reported in previous studies on adolescents with TTH, in which more than 50% of the subjects had achieved clinical improvement (13). The relatively weak effects of relaxation training obtained in the present study are most likely due to the use of a limited number of relaxation training sessions (four). Similar results have also been reported for children with recurrent headaches treated with 2 sessions of relaxation therapy (30). The subjective experience of treatment improvement among treatment completers ('Slightly improved' or 'Much improved') corresponds to rates ranging from 38% to 68% pain reduction on the PI. In a large study on adults suffering from various types of chronic pain, Farrar et al. (31) concluded that a pain reduction of 30% on a VAS corresponded to a clinically relevant change from a patient's perspective. Thus, using a definition of 50% reduction of chronic pain among adolescents as a clinically meaningful improvement might be too conservative.

An important finding in the present study was that clinical improvement of TMD pain complaints among adolescents was well maintained at the 6-month follow-up. Similar results have also been reported for adolescents with TTH treated with relaxation training (32, 33), and for occlusal appliance therapy in adult patients (34).

Furthermore, adolescents treated with occlusal appliance were able to reduce their analgesic consumption significantly more than those in the BI group. However, number of days absent from school did not differ significantly between the groups. Such indicators of treatment outcome have been questioned because of the overall low frequency of medicine usage and school absence reported by school adolescents suffering from frequent headaches (23).

In epidemiological surveys, a reduced opening capacity has been reported among adolescent TMD patients as compared with controls (2) as well as with adults (35). However, in our study no significant effects were found in regard to treatment, a finding in line with another treatment study of adults with TMD (36). Furthermore, although PPTs have been found to increase following treatment (37, 38), here no significant differences in PPT levels were noted between the groups after treatment.

Despite the fact that occlusal appliances have been reported to be the most commonly used therapy in dental praxis in the treatment of adolescents with TMD (6), to date there is only limited empirical support for such intervention in the field (15). For example, in an uncontrolled study, beneficial effects of occlusal appliances in adolescents were reported (5). Although a decreased activity in the jaw muscles has been proposed as a mechanism, the empirical results are contradictory in that both decreases and increases in EMG activity have been reported (39). Relaxation training methods have been assumed to reduce increased levels of muscle tension in the head. Studies of adult headache sufferers suggest that positive effects of relaxation training are primarily related to changes in cognitive processes such as increased self-control (40).

In several studies, relaxation treatment methods have been found to be effective for adolescents suffering from recurrent headaches (14, 23). Therapist-assisted approaches seem to be more powerful in that a higher proportion of subjects have achieved a clinically significant improvement with therapist assistance than without such assistance; for example, treatments administered in home-based, self-help formats (23).

In the present study, the therapist-based relaxation training program used was similar to the one evaluated in previous treatment studies of adolescents with recurrent headache (23). In contrast to previous interventions for adolescent headache suffers treated in combined small group and individual formats, the patients in the relaxation group were treated individually. To compare relaxation training with occlusal appliance therapy, we used the same number of treatment sessions conducted during the same length for both groups. Based on the usual number of visits in dental practices for occlusal appliance therapy, the groups underwent 4 treatment sessions. However, the reduced number of sessions in this study being lower than those administered in previous studies on recurrent headache among adolescents (8–10 sessions) (23) may explain the modest results of relaxation therapy for TMD pain found in the present study.

All the patients in the present study were referred to a TMD clinic and had a perceived request for professional help because of their pain. From an ethical point of view, we decided to provide all participants with some treatment. In an uncontrolled study of adult TMD patients, a majority reported improvement at a short-term follow-up conducted after one treatment session of counseling (41). In the present study, a minority of the patients receiving only brief information improved over time, which is in line with previous outcomes for adolescents with TTH who received extensive information or performed self-recordings of headaches only (13).

After treatment, more than 50% of the adolescents in the BI + RT group reported that they practiced relaxation several times a week and 78% in the BI + OA group used the splint regularly. This difference in compliance might also contribute to the higher pain reduction in the latter treatment group.

One potential contributing or causative factor behind TMD is bruxism (42). Although more than 40% of all the patients in the 3 treatment groups reported bruxism, separate analyses for subjects treated with occlusal appliance showed a low association between reported bruxism and a clinically relevant pain improvement. One reason for this finding could be the limited validity of self-reported bruxism, as pointed out by Marbach et al. (43).

In conclusion, the findings of the present experimental between-group study including a 6-month follow-up can be generalized for treatment completers with TMD pain having more severe pain and higher treatment motivation than non-completers. The results showed that treatment

with an occlusal appliance was superior to 4 sessions of relaxation training and brief information only, regarding pain reduction. Occlusal appliance therapy—being safe and without adverse effects—can therefore be recommended when treating adolescents with TMD pain. The results of previous research on chronic headache among adolescents in particular suggest that an increased number of sessions with a therapist, integrated with other cognitive-behavioral pain strategies, might further enhance the effectiveness of psychological treatments for adolescents with TMD pain.

In future research, evaluations should focus on various ways of optimizing treatment outcomes for adolescents with TMD pain and of identifying the characteristics of responders and non-responders to treatment.

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