Predictors of Clinically Significant Outcome for Adolescents with Temporomandibular Disorders

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Aims: To evaluate and identify baseline characteristics of the adolescent patients included in two previous randomized controlled trials (RCTs) that may predict a clinically significant outcome after treatment of temporomandibular disorders (TMD) with an occlusal appliance (OA) or relaxation training (RT) in a clinical sample of adolescents. **Methods:** This study combined two patient samples from the earlier RCTs for a total of 167 adolescents with frequent TMD pain (once a week or more often), diagnosed according to the Research Diagnostic Criteria for TMD. They were treated with OA, RT, or received information only (control). Outcome (response to treatment vs nonresponse) was assessed using four measures: the Patient Global Impression of Change (PGIC), pain intensity rated on a numeric rating scale (NRS), pain frequency levels, and pain severity levels prospectively recorded in a pain diary. Predictors of outcome were evaluated posttreatment for the whole sample and at 6 months follow-up for participants from the first trial. Associations and differences between groups obtained in the bivariate analyses were further examined in subsequent multivariate logistic regression analyses. **Results:** At posttreatment, treatment condition (OA being more effective than RT/control), gender (boys being more responsive than girls), arthralgia (predicting lower response), lower levels of somatic complaints (predicting better response), and shorter TMD pain history (predicting better response) emerged as significant predictors of a clinical response. At 6-month follow-up, lower consumption of analgesics and shorter TMD pain history emerged as significant predictors of treatment outcome, while treatment condition approached significance after multivariate analysis. **Conclusion:** This study revealed that treatment condition and gender were the most consistent predictors of a clinically significant outcome across outcome measures in a clinical sample of adolescents with TMD. Treatment with OA reduced TMD pain in the adolescents. *J Oral Facial Pain Headache 2017; 31:217–224. doi: 10.11607/ofph.1774*

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Temporomandibular disorders (TMD) are a common group of pain disorders among adolescents in the general population, with overall prevalence estimates for frequent pain (once a week or more often) varying from 4.2% to 7%.[1,2] In a Swedish survey,[2] the rates increased between the ages of 12 and 19 years from 2% to 8%, and from early puberty onward, TMD pain was more prevalent among girls than boys.[1–3]

TMD pain is often associated with other recurrent pain conditions such as tension-type headache and neck and back pain.[4–7] The experience of stress and emotional problems, in particular anxious-depressed symptoms and other somatic complaints, is also more common among adolescents with TMD pain and may have a significant impact on everyday life.[7–9] Among dental factors, self-reported bruxism and oral parafunctional habits,[10–12] as well as restricted range of mandibular movement,[1] have been found to be associated with TMD pain complaints in this age group.

Clinical studies of predictors of outcome in children and adolescents with TMD pain are sparse. In a study by Kitai et al,[13] none of several occlusal variables measured at baseline predicted TMD pain onset

in adolescent girls over a 5-year period. By contrast, in a prospective large-scale cohort study of 11-year-old children assessed every 3 months for 3 years, LeResche et al[14] noted that female gender, somatization, number of other pain conditions, and life dissatisfaction were identified as baseline predictors of facial pain and TMD pain in early adolescence. In a 20-year follow-up study of children and adolescents, temporomandibular joint (TMJ) clicking, bruxism, oral parafunction, and deep bite predicted TMD signs and symptoms later on.[15]

In general population-based surveys, 47% to 66% of young people with frequent TMD pain reported a perceived need for professional help.[1–3] In general dental clinics, occlusal appliance (OA) therapy and counseling have been found to be the most commonly used treatment modalities for TMD among adolescents.[2] While clinical research findings have shown that the majority of these teenagers respond well to conservative treatment,[16] to date, only a few systematic evaluations of the effects of treatment methods for adolescents with TMD have been conducted.

In two previous randomized controlled trials (RCTs), the effects of an OA or relaxation training (RT), both combined with information (ie, standardized information about TMD-related anatomy, TMD pain epidemiology, parafunction, and stress),[17,18] and a control group that received information alone[17] were evaluated after a 3-month treatment period and at a 6-month follow-up. The overall results from these two RCTs showed that adolescents with TMD pain treated with OA reported significantly better pain relief on self-evaluation compared to those treated with RT. Lower treatment motivation and compliance with RT were associated with poorer treatment outcomes. Treatment responders showed a greater motivation and compliance to treatment compared to nonresponders.[17,18]

In adult TMD patients, a number of baseline characteristics have been proposed to predict outcome of cognitive behavioral therapy such as multiple pain sites, levels of depressive symptoms, somatization, catastrophizing, and stress.[19] Nonresponders to TMD treatment were found to report more psychiatric symptoms, poorer coping, and higher levels of catastrophizing at baseline.[20]

To improve treatment outcomes and the prognosis of TMD pain, it is important to understand the factors that contribute to treatment outcome. Given the paucity of studies evaluating the role of treatment predictors for adolescents with TMD, the purpose of the present study was to evaluate and identify baseline characteristics of the adolescent patients included in the two previous RCTs[17,18] that may predict a clinically significant outcome for treatment of TMD with an OA or RT.

Materials and Methods

Subjects, Treatment, and Procedures

The sample in the present study consisted of participants from the two previous RCTs.[17,18] The first sample (RCT 1), recruited between 1996 and 2000, included 122 subjects (93 girls and 29 boys)[17]; the second sample (RCT 2) included 64 subjects (61 girls and 3 boys) who participated in a trial with a crossover design between 2003 and 2011.[18] Altogether, 19 patients (10.3%), 12 from RCT 1 and 7 from RCT 2 before the crossover (second phase), dropped out. Thus, the present combined sample included a total of 167 adolescents with TMD pain (Table 1).

Due to different response rates on the various assessment measures, between 130 and 167 adolescents were included in the analyses for prediction of posttreatment outcome, but only participants from RCT 1—between 49 and 122 adolescents—were included in the analyses at 6 months follow-up. All participants were recruited from a consecutive series of patients referred to the Department of Stomatognathic Physiology in the cities of Linköping and Norrköping, Sweden. The patients and their parents were informed about the study and signed a written consent form to participate. Both studies were approved by the local ethics committee.

The following inclusion criteria were used: aged 12–19 years; experiencing pain at least once a week in the face, jaws, TMJs, or temples for at least 3 months; diagnosed according to the Research Diagnostic Criteria for TMD (RDC/TMD)[21]; and wanting treatment. Excluded were subjects with migraine, patients with ongoing orthodontic treatment that interfered with OA, and those with juvenile idiopathic arthritis.

Assessment

In both the previous RCTs, the assessment was carried out before treatment (baseline), at treatment completion, and at a 6-month follow-up.[17,18] In a questionnaire, the patients reported the intensity, frequency, duration, and location of TMD-related pain, jaw function, tooth clenching and grinding, analgesics consumption, school absence due to TMD pain, and behavioral and emotional problems (see details below). A clinical examination in accordance with RDC/TMD examination guidelines was performed at the pain site, and mandibular movement capacity (mm) and associated pain, presence of joint sounds, and palpatory pain of the temporomandibular muscles and joints were assessed. This procedure allowed establishing the following multiple diagnoses: myofascial pain, disc displacement, and/or arthralgia/arthrosis. Acceptable reliability for the questionnaire, clinical examination, and diagnosis have been previously reported.[22]

Besides age and gender, the following measures were used to assess long-term treatment outcome (detailed information on the various measures can be seen in Table 1):

- TMD pain history: Patients indicated how long (in months) they had experienced pain in the face, jaws, TMJs, or temples.
- Arthralgia and disc displacement: Almost all patients (162 out of 167; 96.7%) were diagnosed with myofascial pain according to the RDC/TMD.[21]
- Headache diagnosis: Episodic tension-type headache was diagnosed according to the International Headache Society diagnostic criteria, first edition.[23]
- Stress: The experiences of 10 common everyday life stressors among adolescents were rated on a 4-point scale: 1 = never, 2 = seldom, 3 = often, and 4 = always, with a sum score ranging from 10 to 40.[24]
- Anxious-depressed and somatic complaints: These subscales included in the widely used and standardized Youth Self-Report (YSR) were used to assess anxious-depressed symptoms (16 items) and somatic complaints (9 items) among adolescents.[25,26] The items were rated on a 3-point scale, where 0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true during the last 6 months.
- School absence: The number of days of school absence during the last month due to TMD pain was estimated.
- Analgesics consumption: Analgesic drug use was rated on a 5-point scale: 1 = never or almost never, 2 = once or twice a month, 3 = once or twice a week, 4 = three to four times a week, and 5 = daily.
- Maximum unassisted pain-free jaw opening: Distance was measured in mm with a ruler between the maxillary and mandibular central incisors, adding vertical overbite.[22]
- Bruxism: Patients were asked if they had been told or they themselves had noticed that they grind or clench their teeth, and their responses were recorded as no or yes.
- Treatment credibility and motivation: Participants were asked to rate the following four items on an 11-point scale: *(1)* How motivated are you to initiate this treatment? (0 = not at all; 10 = very much); *(2)* How much time and work are you willing to put into this treatment? (0 = none; 10 = very much); *(3)* How good do you think this treatment is for the pain you have in your face and temples? (0 = not good at all; 10 = very good); and *(4)* Would you recommend this treatment method to a friend with the same type of pain as you have? (no or yes). The four item values were summed in a treatment credibility sum score (0–40).

Table 1 Distribution of Participants by Gender, Age, Diagnoses, Treatment Type and Credibility, Pain Characteristics, and Physical and Psychosocial Factors at Baseline (N = 167)

Variable	n (%)	Mean (SD)/ median (IQR)
Gender		
Girls	136 (81.4)	
Boys	31 (18.6)	
Age (12–19 y)		15.5 (2.1)
RDC/TMD		
Disc displacement	31 (18.8)	
Arthralgia	43 (26.1)	
Episodic tension-type headache	80 (48.5)	
Treatment		
Occlusal appliance	66 (39.5)	
Relaxation training/control	101 (60.5)	
Treatment credibility/motivation (0–40)		31.0 (6.0)
TMD pain history (mo)		24.0 (19.5)
Maximum unassisted pain-free jaw opening (mm)		47.8 (9.0)
Analgesic consumption (1–5)[a] (n = 165)		2.0 (1.0)
Bruxism	87 (52.4)	
Stress 0–40 (n = 123)		21.8 (5.8)
Youth Self-Report subscale (n = 123)		
Anxious-depressed		7.3 (6.1)
Somatic complaints		5.5 (3.1)
School absence (d/mo) (n = 162)		0.4 (1.4)

[a]Scale end points: 1 = never; 5 = daily. IQR = interquartile range; SD = standard deviation.

Treatment

The treatment methods used in the two previous trials[17,18] were as follows:

In RCT 1, patients were randomly assigned to one of the following three treatment groups: *(1)* OA plus information on TMD; *(2)* four therapist-guided sessions of RT plus information on TMD; and *(3)* information only, given on one occasion (control). RCT 2 consisted of two phases: In the first phase, patients were randomized to either RT administered in eight therapist-assisted sessions or an OA. Both these groups received information before randomization. The second phase included a sequential crossover design in which nonresponders (see criteria below for Patient Global Impression of Change [PGIC]) to treatment after phase 1 were offered the other treatment type.

Table 2 Pain Intensity, Pain Diary, and Pain Frequency Scores at Baseline, Posttreatment, and 6-month Follow-up by Treatment Group

	Baseline (n = 167)	Posttreatment (n = 130 to 167)	Follow-up[a] (n = 84 to 110)
Occlusal appliance			
Pain intensity (NRS, 0–10), mean (SD)	5.6 (1.8)	3.5 (2.1)	2.7 (2.0)
Pain diary (0–140), mean (SD)	34.9 (23.6)	24.2 (24.2)	17.2 (18.9)
Pain frequency (1–5), median (IQR)	3.9 (0.8)	3.0 (2.0)	2.5 (1.0)
Relaxation training/control			
Pain intensity (NRS, 0–10), mean (SD)	5.3 (1.9)	4.3 (2.1)	4.0 (2.2)
Pain diary (0–140), mean (SD)	27.5 (19.9)	21.6 (19.3)	17.0 (20.3)
Pain frequency (1–5), median (IQR)	3.6 (0.8)	3.0 (2.0)	2.9 (1.1)

[a]Data from RCT 1.[17]

Trained and experienced therapists performed the treatment. Information consisted of standardized information about TMD-related anatomy, TMD pain epidemiology, parafunction, and stress. The OA was a stabilization splint placed in the maxilla, designed to produce maximum intercuspation with canine guidance. Patients were requested to use the splint every night up to the first evaluation (at 3 months) and thereafter if they felt the need to use it until the 6-month follow-up. RT included clinic-based training and a manual for home training with audio instructions. The goal was to provide adolescents with an active coping method to be applied in everyday situations at the onset of TMD pain. The importance of regular home practice, at least once a day for 15–20 minutes, was emphasized. The RT program has previously been evaluated in several school-based trials in adolescents with recurrent headache.[27]

Only minor differences between RT and control condition were obtained in the first trial,[17] and the data were therefore combined into one RT/control (RT/Co) group in the present outcome analyses.

Treatment Outcome

The participants in the two trials were asked to assess their overall improvement after treatment and at the 6-month follow-up. They also rated their current pain experience before and after treatment and at the 6-month follow-up. The following four outcome measures were considered for evaluation of clinically significant treatment outcome: *(1)* PGIC; *(2)* ratings of pain intensity on a numeric rating scale (NRS); *(3)* pain frequency levels; and *(4)* pain severity levels recorded in a pain diary (Table 2). An initial analysis was first carried out to estimate the agreement between these four measures using dichotomous levels to reflect a clinically significant change with Kappa statistics. Because the results showed that Kappa coefficients varied from 0.30 to 0.34, indicating a low agreement level between the four measures, all of them were included in the outcome analyses.

PGIC

The adolescents rated their subjective experience of change on the following standardized scale: 1 = much improved or completely cured, 2 = slightly improved, 3 = no change, 4 = slightly worsened, and 5 = much worse. Participants who reported to be much improved or completely cured were regarded as having achieved a clinically significant improvement; ie, they were defined as treatment responders.

NRS

On this 0–10 scale, the adolescents rated their current pain intensity due to TMD. In a recent validation study in adults with TMD, Emshoff et al[28] noted that a pre–post reduction in pain intensity of 38% corresponded to a subjective experience of being much improved or completely cured on the PGIC. Given that reduction rates have varied between 30% and 36% in previous clinical validation studies of pain, this analysis used a reduction of 35% for pain intensity (NRS35%) to indicate a clinically significant improvement.

Pain Frequency

Participants scored this dimension on the following 5-point scale: 1 = never, 2 = once or twice a month, 3 = once a week, 4 = several times a week, and 5 = daily. Using the inclusion criterion of having TMD pain at least once a week as a cutoff, having achieved a pain frequency of less than once a week at both posttreatment and follow-up was regarded as a clinical reduction of pain.

Pain Diary

Patients recorded TMD pain intensity in a pain diary four times daily: at breakfast, lunch, dinner (after school), and bedtime. In each phase, participants rated their daily pain experience over the course of 1 week. They rated pain on a 6-point behavioral rating scale with the following endpoints: 0 = no pain and 5 = very intense pain, totally handicapped, can't do anything. Sum scores for this measure, here defined as weekly pain sum, ranged from 0 to 140. A pre–post and pre–follow-up reduction in pain intensity of ≥ 50% was used to define responders to treatment. This cutoff is commonly used to reflect a clinically significant change in adolescents suffering from recurrent headaches.[27]

Statistical Analyses

Descriptive statistics were used to report percentages, means, and standard deviations (SDs) for continuous

variables, and the medians and interquartile ranges (IQR) for ordinal variables. In analyses of bivariate correlations between categorical and continuous variables, chi-square test and Pearson product-moment correlations were used. Differences in means between independent groups in continuous variables were examined with Student *t* test.

Predictors of posttreatment and follow-up change for the four dichotomous outcome variables (responders vs nonresponders) were then analyzed with logistic regression. Here, explaining factors reaching a *P* value of ≤ .10 in bivariate correlations were included in subsequent multivariate analyses. B coefficients, standard error (SE), *P* values, and odds ratios (ORs) with 95% confidence intervals (95% CI) were estimated. The Hosmer and Lemeshow test was used to test model fit. An alpha level of $P < .05$ indicated statistical significance.

Results

Posttreatment Outcome Predictors

PGIC

The results of bivariate analyses showed that the following explaining factors were significantly associated with a clinically significant response according to subjective evaluation on the PGIC: treatment condition (OA 74% vs RT/Co 26%, χ^2 [1] = 18.05, $P < .001$); treatment credibility sum score (mean 33.0 for responders vs 30.7 for nonresponders, t [160] = –2.01, $P < .05$); bruxism (25.6% among those with bruxism responded vs 11.8% of those without bruxism, χ^2 [1] = 4.92, $P < .05$); disc displacement (31.2% responders with disc displacement vs 16% without, χ^2 [1] = 3.87, $P < .05$); and maximum unassisted pain-free jaw opening (mean distance of 43.7 mm for responders vs 48.9 mm for nonresponders, t [161] = 2.95, $P < .05$).

The results of subsequent logistic regression analysis (n = 161) showed that only treatment condition (OA > RT/Co) predicted a positive treatment response (B = –1.59, SE = 0.47, OR = 4.9 [95% CI 1.92–12.5], $P < .001$). The Hosmer and Lemeshow test was nonsignificant.

NRS35%

Treatment condition and gender emerged as significant predictors in bivariate analyses. About half of the adolescents (50.7%) who responded to treatment were treated with OA, as compared to 22.8% treated with RT/Co (χ^2 [1] = 14.34, $P < .001$). Similarly, 50% of the boys responded to treatment, while only 30.7% of girls responded (χ^2 [1] = 4.30, $P < .05$). Although a higher response rate was found among those with disc displacement (46.9%) compared to those without (30.4%), the association was nonsignificant ($P = .08$).

The results of logistic regression analysis (n = 165) showed that treatment condition predicted a clinically significant outcome with the following parameters: B = 1.42, SE = 0.36, OR = 4.12 (95% CI 2.05–8.29), $P < .001$. For gender, the corresponding values were: B = 0.78, SE = 0.44, OR = 2.18 (95% CI 0.92–5.20), $P = .08$. The Hosmer and Lemeshow test was nonsignificant.

Pain Frequency

The results of the bivariate analyses showed that gender was associated with having reached a pain frequency level of less than once a week (or no pain) at the posttreatment assessment (boys 43.8% and girls 28.6%, χ^2 [1] = 2.79, $P = .10$). Lower responses were also found for those with arthralgia (14%) vs no arthralgia (37%) (χ^2 [1] = 7.96, $P < .01$) and bruxism (25%) vs absence of bruxism (37.3%) (χ^2 [1] = 3.05, $P = .08$). Lower levels of somatic complaints (mean value of 4.4 for responders vs 5.9 for nonresponders, t [112] = –2.31, $P < .05$) and a shorter TMD pain history (mean of 15.6 for responders vs 23.5 for nonresponders, t [170] = –3.13, $P < .01$) predicted a better response. Although the response was better for adolescents treated with OA (35.2%) compared to the RT/Co group (28.7%), this difference was nonsignificant.

The results of the subsequent logistic regression analysis (n = 113) showed that gender, arthralgia, somatic complaints, and TMD pain history predicted a favorable outcome, with the following parameters: B = –1.62, SE = 0.64, OR = 5.05 (95% CI 1.46–17.54), $P < .01$; and B = 1.94, SE = 0.62, OR = 6.93 (95% CI 2.04–23.53), $P < .001$, B = 0.21, SE = 0.10, OR = 1.23 (95% CI 1.02–1.48), $P < .05$; and B = 0.05, SE = 0.02, OR = 1.05 (95% CI 1.01–1.08), $P < .01$, respectively. The Hosmer and Lemeshow test was nonsignificant.

Pain Diary

The results of the bivariate analyses showed that treatment condition approached a significant association with response vs nonresponse (χ^2 [1] = 3.80, $P = .05$) in that 44.1% of adolescents in the OA group responded to treatment compared to 27% among those in the RT/Co group. Again, gender emerged as a significant predictor in that boys responded to treatment more often compared to girls (55% vs 29.3%, respectively, χ^2 [1] = 4.93, $P < .05$). While treatment credibility sum scores were higher among responders compared to nonresponders, this difference was nonsignificant ($P = .09$).

The results of a subsequent logistic regression analysis (n = 118) showed that treatment condition and gender emerged as significant predictors, with the following estimates: B = 0.94, SE = 0.44, OR = 2.56 (95% CI 1.08–6.05), $P < .05$; and B = 1.48, SE = 0.56, OR = 4.41 (95% CI 1.47–13.21), $P < .01$, respectively. The Hosmer and Lemeshow test was nonsignificant.

Predictors of Follow-up Outcome

Due to the crossover design of the second trial, analyses of predictions of outcome at the 6-month follow-up were restricted to adolescents included in the first trial.

The results of the bivariate analyses showed an association for gender in that a higher proportion of boys (15%) compared to girls (5%) were responders on the PGIC; however, this association was nonsignificant ($P = .09$). While lower levels of anxious-depressed and total stress scores significantly ($P < .05$) predicted a response at follow-up in diary recordings, none of these explaining factors emerged as significant predictors in a subsequent logistic regression analysis. In further pre–follow-up evaluations on the NRS35%, treatment condition (OA 64% vs RTCo 34%, χ^2 [1] = 9.71, $P < .01$) and gender (boys 62% vs girls 40%), χ^2 [1] = 4.45, $P < .05$) emerged as significant bivariate predictors of outcome. Levels on the anxious-depressed subscale (t [55] = 2.22, $P < .05$) and TMD pain history (t [113] = 1.99, $P < .05$) were also significantly lower among responders compared to nonresponders (mean values were 5.3 vs 8.9 and 17.3 vs 24.1, respectively). Again, none of these explaining factors emerged as significant contributors to outcome in the subsequent logistic regression analysis (n = 49).

Regarding frequency of pain levels, treatment group was associated with a favorable outcome (57.1% responders in the OA group vs 42.5% in RTCo group, χ^2 [1] = 2.30, $P = .12$). A better response was also predicted by a lower baseline consumption of analgesics (the mean value for responders 1.9 vs 2.3 for nonresponders, t [112] = –2.54, $P < .05$) and shorter TMD pain history (mean for responders 16.1 vs nonresponders 25.6, t [113] = –2.91, $P < .01$). Whereas the results of the subsequent logistic regression analysis showed that treatment group approached significance as a predictor (B = –0.82, SE = 0.43, OR = 2.26 [95% CI 0.97–5.26], $P = .06$), both baseline analgesic consumption and TMD pain history emerged as significant predictors of outcome (B = 0.56, SE = 0.22, OR = 1.74 [95% CI 1.13–2.67], $P < .05$; and B = 0.03, SE = 0.01, OR = 1.03 [95% CI 1.01–1.06], $P = .01$, respectively). Hosmer and Lemeshow test was nonsignificant.

Discussion

In the present study of a combined clinical sample of 167 adolescents with frequent TMD pain (once a week or more often) and treated with OA or RT/Co in two previous RCTs, predictors of clinically significant outcome were evaluated posttreatment for the whole sample and at a 6-month follow-up for participants included in RCT 1. At both posttreatment and follow-up, a number of factors were identified as predictors of a clinically significant response across four outcome measures. In the multivariate regression analyses, treatment condition (OA being more effective than RT/Co) and gender (boys being more responsive than girls) emerged as the most consistent predictors across the pre–post outcome measures. While arthralgia (predicting lower response), lower levels of somatic complaints (predicting better response), and shorter TMD pain history (predicting better response) among responders were also found to be baseline predictors, the findings were restricted to only one of the outcome measures: frequency of pain levels. At 6 months follow-up, lower consumption of analgesics and shorter TMD pain history emerged as significant predictors of positive treatment outcome, while treatment condition approached significance, in the multivariate regression analyses; however, this outcome was restricted to the frequency of pain levels measure.

In almost all previous treatment outcome studies of different types of recurrent pain among adolescents, statistical between-group comparisons were carried out to establish effectiveness of various intervention methods, ignoring the subjectivity of an individual's pain experience.[29] In a meta-analysis of RCTs of treatment for recurrent headache in children and adolescents,[30] outcome was found to depend on the type of pain characteristic used. In light of this result and due to low agreement between the four dichotomous outcome measures (Kappa coefficients of 0.30 to 0.34), three other pain variables, in addition to subjective ratings of treatment success, were included to assess outcome in the present prediction analyses.

The present study used a cutoff level of 35% pre–posttreatment pain intensity reduction in ratings on the commonly used, standardized NRS (0–10 NRS). Such a cutoff level to define clinical improvement has also been used in a previous RCT including adults with TMD[31] and was recently validated in adults having been treated for TMD.[28]

A commonly used statistical criterion in the assessment of frequent headache among adolescents is a 50% reduction of complaints in prospective diary recordings.[27] However, to the best of the authors' knowledge, this criterion has not yet been validated against the adolescent individual's own experience of pain reduction and its clinical importance.

In both the previous trials, a significantly higher proportion of adolescents responded to treatment with OA compared to RT/Co.[17,18] In the present study, when the two samples were combined, resulting in higher statistical power, treatment condition emerged as the most consistent predictor of a positive outcome, with OA treatment producing a higher proportion of responders. This outcome is important: It indicates that

the finding is valid and reliable and that the well-established and common clinical treatment with OA of adolescents suffering from frequent TMD is effective.

Gender was found to predict outcome, in that boys responded better to treatment compared to girls. Similar findings have been reported for adult male patients responding better to treatment compared to adult female patients.[32] In cross-sectional studies, adolescent girls with frequent TMD pain commonly report more somatic complaints and more anxious-depressed symptoms, consume more analgesics for TMD pain, have higher perceived need for TMD treatment, and also seek caregivers more often for other bodily pain compared to boys with the same pain disorder.[4,8] These problems indicate that girls with TMD pain have a more pronounced psychosocial vulnerability than boys. The use of coping strategies for frequent pain also differs between boys and girls; for example, in a study of children and adolescents with chronic pain, girls reported greater use of social support seeking, whereas boys made greater use of distractions.[33] Therefore, both psychosocial factors and the strategies boys and girls adopt to cope with pain may explain the obtained differences in treatment response between genders.

A longer TMD pain history was associated with poorer recovery after treatment, a finding also reported for adult TMD patients.[34] Such a relationship could depend on a decline in the individual's use of active coping strategies when pain persists over an extended time, negatively affecting the patient's view on their usefulness to ameliorate pain. Among adult TMD patients, catastrophizing thoughts when pain recurs have been associated with a negative treatment outcome.[19] It is likely that such ideation may also negatively impact treatment response among adolescents with a longer TMD history.

A greater number of pain sites and higher levels of psychosocial problems have been suggested to be important risk factors that may produce a less favorable outcome in adult patients with TMD pain.[19,35,36] It should be noted, however, that while higher levels of anxious-depressed symptoms, somatic complaints, and total stress scores were factors associated with poorer outcome in the present study, the overall findings were inconsistent and dependent on type of outcome measure and assessment time point.

About a quarter of the adolescents (27.2%) received a diagnosis of arthralgia solely or combined with other TMD diagnoses. A positive treatment outcome has been reported for adult patients with TMD pain of arthrogenous origin treated with an OA compared to a control splint.[32] The present study found that adolescents with arthralgia may face an increased risk of being nonresponders to treatment. Of particular note in the present study is that none of the clinical dental factors, such as self-reported bruxism and maximum unassisted pain-free jaw opening, predicted outcome.

Although the power in the study's statistical analyses of pre–posttreatment predictors across measures was adequate, a limitation was the relatively weak power in the follow-up evaluations. The strengths of the present study are the inclusion of a relatively large sample of adolescents with TMD recruited from the same health region and the use, at the same time points, of a standardized assessment using identical measures.

Conclusions

The findings of the present study showed that the commonly used treatment method of OA in clinical practice for adolescents suffering from TMD is effective, but also that gender emerged as the most consistent predictor of a clinically significant response across outcome measures. While a substantial proportion of individuals responded with a clinically significant improvement across different outcome measures, depending on the outcome measure used, about one-quarter to half of the sample were nonresponders to the most effective treatment (OA) at both time points (treatment completion and 6-month follow-up). These results therefore underline that the effectiveness of treatment for adolescents suffering from TMD needs to be further improved, in particular for teenage girls suffering from the disorder. The findings should also be further tested in RCTs replicated at other sites, preferably with the inclusion of larger sample sizes.

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References

1. List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: Prevalence of pain, gender differences, and perceived treatment need. J Orofac Pain 1999;13:9–20.
2. Nilsson IM, List T, Drangsholt M. Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. J Orofac Pain 2005;19:144–150.
3. Hongxing L, Astrøm AN, List T, Nilsson IM, Johansson A. Prevalence of temporomandibular disorder pain in Chinese adolescents compared to an age-matched Swedish population. J Oral Rehabil 2016;43:241–248.
4. Hirsch C, John MT, Schaller HG, Türp JC. Pain-related impairment and health care utilization in children and adolescents: A comparison of orofacial pain with abdominal pain, back pain, and headache. Quintessence Int 2006;37:381–390.

5. Nilsson IM, List T, Drangsholt M. Headache and co-morbid pains associated with TMD pain in adolescents. J Dent Res 2013;92:802–807.
6. Karibe H, Shimazu K, Okamoto A, Kawakami T, Kato Y, Warita-Naoi S. Prevalence and association of self-reported anxiety, pain, and oral parafunctional habits with temporomandibular disorders in Japanese children and adolescents: A cross-sectional survey. BMC Oral Health 2015;15:8.
7. List T, Wahlund K, Larsson B. Psychosocial functioning and dental factors in adolescents with temporomandibular disorders: A case-control study. J Orofac Pain 2001;15:218–227.
8. Nilsson IM, Drangsholt M, List T. Impact of temporomandibular disorder pain in adolescents: Differences by age and gender. J Orofac Pain 2009;23:115–122.
9. Hirsch C, Türp JC. Temporomandibular pain and depression in adolescents—A case-control study. Clin Oral Investig 2010;14:145–151.
10. van Selms MK, Visscher CM, Naeije M, Lobbezoo F. Bruxism and associated factors among Dutch adolescents. Community Dent Oral Epidemiol 2013;41:353–363.
11. Franco-Micheloni AL, Fernandes G, de Godoi Gonçalves DA, Camparis CM. Temporomandibular disorders in a young adolescent Brazilian population: Epidemiologic characterization and associated factors. J Oral Facial Pain Headache 2015;29:242–249.
12. Fernandes G, van Selms MK, Gonçalves DA, Lobbezoo F, Camparis CM. Factors associated with temporomandibular disorders pain in adolescents. J Oral Rehabil 2015;42:113–119.
13. Kitai N, Takada K, Yasuda Y, Verdonck A, Carels C. Pain and other cardinal TMJ dysfunction symptoms: A longitudinal survey of Japanese female adolescents. J Oral Rehabil 1997; 24:741–748.
14. LeResche L, Mancl LA, Drangsholt MT, Huang G, Von Korff M. Predictors of onset of facial pain and temporomandibular disorders in early adolescence. Pain 2007;129:269–278.
15. Carlsson GE, Egermark I, Magnusson T. Predictors of signs and symptoms of temporomandibular disorders: A 20-year follow-up study from childhood to adulthood. Acta Odontol Scand 2002;60:180–185.
16. Skeppar J, Nilner M. Treatment of craniomandibular disorders in children and young adults. J Orofac Pain 1993;7:362–369.
17. Wahlund K, List T, Larsson B. Treatment of temporomandibular disorders among adolescents: A comparison between occlusal appliance, relaxation training, and brief information. Acta Odontol Scand 2003;61:203–211.
18. Wahlund K, Nilsson IM, Larsson B. Treating temporomandibular disorders in adolescents: A randomized, controlled, sequential comparison of relaxation training and occlusal appliance therapy. J Oral Facial Pain Headache 2015;29:41–50.
19. Turner JA, Holtzman S, Mancl L. Mediators, moderators, and predictors of therapeutic change in cognitive–behavioral therapy for chronic pain. Pain 2007;127:276–286.
20. Litt MD, Porto FB. Determinants of pain treatment response and nonresponse: Identification of TMD patient subgroups. J Pain 2013;14:1502–1513.
21. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: Review, criteria, examinations and specifications, critique. J Craniomandib Disord 1992;6: 301–355.
22. Wahlund K, List T, Dworkin SF. Temporomandibular disorders in children and adolescents: Reliability of a questionnaire, clinical examination, and diagnosis. J Orofac Pain 1998;12:42–51.
23. Classification and diagnostic criteria for headache disorders, cranial neuralgias and facial pain. Headache Classification Committee of the International Headache Society. Cephalalgia 1988;8(suppl):s1–s96.
24. Larsson B. The role of psychological, health-behaviour and medical factors in adolescent headache. Dev Med Child Neurol 1988;30:616–625.
25. Achenbach TM. Manual for the Youth Self-Report and 1991 Profile. Burlington, VT: University of Vermont Department of Psychiatry, 1991.
26. Broberg AG, Ekeroth K, Gustafsson PA, et al. Self-reported competencies and problems among Swedish adolescents: A normative study of the YSR. Youth Self Report. Eur Child Adolesc Psychiatry 2001;10:186–193.
27. Larsson B, Carlsson J, Fichtel A, Melin L. Relaxation treatment of adolescent headache sufferers: Results from a school-based replication series. Headache 2005;45:692–704.
28. Emshoff R, Emshoff I, Bertram S. Estimation of clinically important change for visual analog scales measuring chronic temporomandibular disorder pain. J Orofac Pain 2010;24:262–269.
29. Birnie KA, McGrath PJ, Chambers CT. When does pain matter? Acknowledging the subjectivity of clinical significance. Pain 2012;153:2311–2314.
30. Trautmann E, Lackschewitz H, Kröner-Herwig B. Psychological treatment of recurrent headache in children and adolescents—A meta-analysis. Cephalalgia 2006;26:1411–1426.
31. Nilsson H, Limchaichana N, Nilner M, Ekberg EC. Short-term treatment of a resilient appliance in TMD pain patients: A randomized controlled trial. J Oral Rehabil 2009;36:547–555.
32. Ekberg E, Nilner M. The influence of stabilisation appliance therapy and other factors on the treatment outcome in patients with temporomandibular disorders of arthrogeneous origin. Swed Dent J 1999;23:39–47.
33. Lynch AM, Kashikar-Zuck S, Goldschneider KR, Jones BA. Sex and age differences in coping styles among children with chronic pain. J Pain Symptom Manage 2007;33:208–216.
34. Gale EN, Funch DP. Factors associated with successful outcome from behavioral therapy for chronic temporomandibular joint (TMJ) pain. J Psychosom Res 1984;28:441–448.
35. Fricton JR, Olsen T. Predictors of outcome for treatment of temporomandibular disorders. J Orofac Pain 1996;10:54–65.
36. Grossi ML, Goldberg MB, Locker D, Tenenbaum HC. Reduced neuropsychologic measures as predictors of treatment outcome in patients with temporomandibular disorders. J Orofac Pain 2001;15:329–339.