Time Courses of Myofascial Temporomandibular Disorder Complaints During a 12-Month Follow-up Period

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Aims: *To investigate the time courses of myofascial temporomandibular disorder (TMD) pain and mandibular function impairment (MFI), and to identify predictive factors associated with these time courses.* ***Methods:*** *During a 12-month period following conservative TMD treatment, the time courses of myofascial TMD pain and pain-related disabilities were assessed by questionnaires. Ninety-six myofascial TMD patients participated, of whom 70 completed the study. Before treatment (baseline data), Characteristic Pain Intensity (CPI), MFI, parafunctional activities, and psychological status were assessed, and at completion of treatment and at 3, 6, 9, and 12 months, CPI and MFI were scored again. Individual time courses in scores were analyzed using linear growth modeling.* ***Results:*** *Baseline values of CPI had a positive correlation with CPI during follow-up (*P = .002*), whereas the influences of reported parafunctions and of pain elsewhere on CPI scores were close to significance (*P = .058 and .06, respectively*). Patients with a low somatization score showed a further decline in CPI during follow-up (*P = .027*), whereas patients with a high score showed a gradual increase (*P = .030*). Baseline values of MFI were positively correlated with MFI scores during the follow-up period (*P = .000*). The influence of reported parafunctions on MFI was not significant (*P = .174*), but that of pain elsewhere was (*P = .004*). The trend for a further decline in MFI values during follow-up was close to significance (*P = .063*) for patients with low somatization scores. Patients with high somatization scores showed a significant increase in MFI values (*P = .007*).* ***Conclusion:*** *Baseline reports of pain and impairment, oral parafunctional activities, pain elsewhere in the body, and somatization are associated with the severity and time course of myofascial TMD complaints following treatment.* J OROFAC PAIN 2009;23:345–352

Key words: mandibular function impairment, myofascial TMD pain, prognosis, time course

Temporomandibular disorders (TMD) constitute the most prevalent category of nondental chronic pain conditions in the orofacial region. TMD comprise clusters of musculoskeletal disorders affecting the temporomandibular joint, the muscles of mastication, and/or the associated structures. In most patients, the pain predominantly emanates from the muscles of the masticatory system (ie, myofascial TMD pain).[1]

Myofascial TMD pain often has a remitting, self-limiting, or fluctuating character.[1] Unfortunately, cohort studies of the natural course of myofascial TMD pain are scarce and hampered by the

fact that some of the patients involved may be in a phase of increasing pain complaints while others may be in a phase of remission. This asynchrony in the disorder's time course will compromise the search for factors associated with the natural course of the disorder. In this context it is noteworthy that, irrespective of the employed treatment modality, approximately 70% to 90% of patients presenting with myofascial TMD pain show a marked improvement after conservative (reversible) treatment.[1] This improvement immediately after treatment more or less synchronizes the subsequent time courses of the disorder of individual patients, and this offers good opportunities for a follow-up study of the natural time course and the factors associated with it.

Therefore, the aim of the present study was to investigate the time courses of myofascial TMD pain and mandibular function impairment (MFI) of individual patients, and to identify predictive factors associated with these time courses. Since study designs with multiple measurements are necessary for monitoring the course of a condition,[2] the study participants were monitored five times at regular time intervals during a 12-month time period following conservative (reversible) treatment for their myofascial TMD pain complaints.

Materials and Methods

Study Sample

Patients with complaints of pain in the orofacial region lasting for at least 1 month, who were referred by their dentist or medical practitioner to the clinic for Oral Kinesiology of the Academic Centre for Dentistry Amsterdam (ACTA), were invited to participate. During the first visit, an oral history was taken and trained examiners performed a clinical examination according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).[3,4] Patients were included if they met the following criteria: *(1)* willing to participate in the study, after giving a written informed consent, *(2)* a clinically confirmed RDC/TMD diagnosis of myofascial pain, *(3)* no systemic disease, *(4)* no other orofacial disorders (eg, trigeminal neuralgia), *(5)* over 18 years old, *(6)* a good understanding of the Dutch language, *(7)* no severe psychiatric disorders, and *(8)* no overuse of painkillers. In addition to the myofascial pain diagnosis, patients could have other, non-painful RDC-diagnosed TMDs. The interrater reliability for the diagnosis of myofascial pain was established earlier and was considered fair to good.[4] Following the initial examination, the patients received customary, conservative treatments provided by clinicians experienced in the treatment of TMD patients. Besides counseling, treatment typically included occlusal splint therapy, physiotherapy, cognitive behavior modification therapy, or combinations of these treatment modalities. The decision to end the treatment was based on the assessment of whether further treatment would be of substantial benefit to the patient. This study was approved by the local medical ethics committee.

Observations

During the entire study, each patient received a total of six questionnaires at six predetermined points in time. Questionnaires were given at the first visit to the clinic (baseline) and directly after completion of treatment (posttreatment). The other questionnaires were sent by mail at 3, 6, 9, and 12 months following treatment. Participants received a reminder telephone call or a reminder was sent by mail whenever a questionnaire was not returned within 2 to 3 weeks.

Outcome Variables

As outcome variables, two frequently used indicators for TMD pain and TMD-related disabilities were used:

1. The Characteristic Pain Intensity (CPI) as incorporated in the RDC/TMD.[3] The CPI score is calculated by taking the mean score of 3 (0 to 10) pain ratings of the current pain, the average, and the worst pain in the last 3 months, and by multiplying this score by 10. The CPI score may range from 0 to 100.
2. The MFI, assessed using the Mandibular Function Impairment Questionnaire (MFIQ).[5] The MFIQ contains 17 items, and each item is scored on a five-point Likert scale (0 = no difficulty, 4 = very difficult or impossible without help) on which the patient can indicate how much difficulty is experienced performing a particular mandibular task (eg, chewing or eating hard food or a hard cookie). The total MFI score may range from 0 to 1 and is obtained by dividing the sum of the items by four times the number of items.

Prognostic Factors

Beside age (years), gender (0 = female; 1 = male), and the CPI and MFI baseline scores, the following variables collected at baseline were used as possible prognostic factors for the time course of the TMD complaints:

1. Parafunctional activities, using a three-scale oral parafunctions questionnaire.[6] The first scale includes four clenching and grinding items; the second scale includes three items about biting and chewing activities; and the third scale includes five items on tongue, lip, and cheek activities. Answers are given on a five-point Likert scale, ranging from 0 (never) to 4 (always). The total parafunctional activity score was calculated by dividing the sum score by four times the number of items, and has a range from 0 to 1.
2. Depression and somatization, measured by two scales of the Dutch translation of the Symptom Check List (SCL-90).[7,8] The depression scale assesses negative mood and vegetative symptoms of poor functioning. The somatization scale assesses distress related to bodily symptoms, such as faintness and stomach upset. A shortened somatization scale, excluding four pain-related questions, was used to avoid confounding with questions assessing pain throughout the body. Each of the questions is rated on a five-point Likert scale, ranging from 1 (not at all) to 5 (very much), indicating the severity of symptoms over the past week. The depression and somatization scores were dichotomized using thresholds set at the 80th percentile of the depression and somatization scores obtained in the Dutch population.[6] Scores above (below) the threshold were coded as 1 (0).
3. Duration of pain complaints (pain chronicity) in months.
4. Pain elsewhere: Do you feel pain elsewhere in your body? The answer was "no" (coded as 0) or "yes" (coded as 1).
5. Previous treatment for complaints of TMD pain. The answer was "no" (coded as 0) or "yes" (coded as 1).

Analysis

To identify potential prognostic factors that are associated with the time course of the two outcome variables during follow-up, their effects were analyzed using conditional linear growth models. These models allow the change over time in the phenomenon of interest (in this study, the CPI and MFI scores) to be assessed at both the aggregate (ie, sample) and the individual (ie, the study participant) levels:

Level 1:

$$CPI_{ij}, \text{ or } MFI_{ij} = b_{0i} + b_{1i}*time_j + r_{ij}$$

Level 2:

Initial status:

$$b_{0i} = b_{00} + b_{01}*predictor_{1i} + b_{02}*predictor_{2i} + ...+ \nu_{0i}$$

Slope:

$$b_{1i} = b_{10} + b_{11}*predictor_{1i} + b_{12}*predictor_{2i} + ...+ \nu_{1i}$$

The subscripts "i" and "j" denote person and measurement occasion, respectively. $Time_j$ was coded from 0 to 4 (0 for the posttreatment occasion and 1 to 4 for the measurement occasions 3, 6, 9, and 12 months later). The level 1 model describes the individual linear growth trajectories for the amount of pain (CPI_{ij}) or mandibular impairment (MFI_{ij}) during the 12-month follow-up period following treatment. Specifically, b_{0i} and b_{1i} are the individual i's intercept and growth rate, and the time-specific residual term r_{ij} captures the deviation between individual i's predicted and observed value at time point j. In the level 2 model, each individual's initial status (b_{0i}) and slope (ie, growth rate; b_{1i}) estimates are described as a function of three components: *(1)* the population estimate (b_{00} for initial status and b_{10} for slope), *(2)* the effects of the predictors on the initial status (b_{01}, b_{02}, ...) and on the slope ($b_{11,}$ b_{12}, ...), and *(3)* an individual deviation (ν_{0i} for initial status and ν_{1i} for slope).[9]

The effects of the predictors were first separately analyzed using conditional linear growth models with only one prognostic factor (predictor) in the model at the time (univariate analysis). Subsequently, all significant prognostic factors from the univariate analyses (predictors, time, and/or interaction term with time) were entered into the final linear growth model (multivariate model) to obtain the set of variables that was best associated with the outcome variable under study. To improve the interpretation of the model parameters, the continuous prognostic factors (age, parafunctional activities, pain chronicity, $CPI_{baseline}$ and $MFI_{baseline}$) were grand mean recentered to have a mean value of 0.[9]

To check for significant differences in baseline characteristics between dropout participants and participants with a complete follow-up, independent *t*-tests and Chi-square tests were used. The

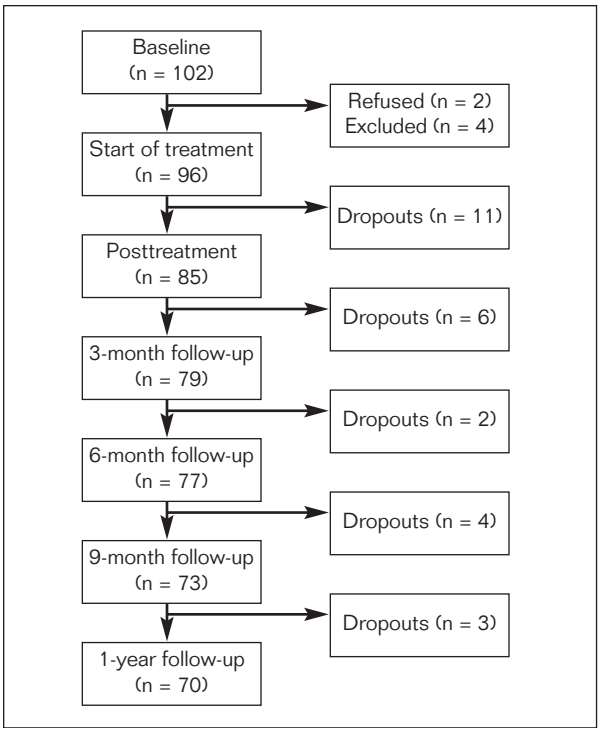

Fig 1 Flowchart describing the number of study participants at each time point.

Table 1 Descriptive Baseline Data of the 85 Patients Included in the Analyses

Gender	
Female	76
Male	9
Pain elsewhere	
No	46
Yes	39
Previous treatment	
No	40
Yes	45
Somatization	
Below cutoff	70
Above cutoff	14
Missing	1
Depression	
Below cutoff	62
Above cutoff	21
Missing	2
CPI	48.6 (± 25.3)
MFI	0.395 (± 0.219)
Pain chronicity (mo)	41.8 (± 52.8)
Parafunctional activities	0.238 (± 0.152)

Numbers of participants shown for the five dichotomous prognostic factors (*top*) and the mean value (± SD) for the four continuous prognostic factors (*bottom*).

conditional linear growth modeling was conducted using linear-mixed effects modeling incorporated in the SPSS software package, version 16.0 (SPSS). In the univariate models, statistical significance was set at $P < .1$; in the final models with multiple prognostic factors, significance was set at $P < .05$.

Results

One hundred and two myofascial TMD pain patients attending the clinic were approached to participate in this study. Of these patients, two patients refused to participate, while four patients were excluded from the study because they no longer reported pain at the start of treatment or because they suffered from an endodontic pain. Additionally, 11 patients expressed their wish to withdraw from the study at completion of treatment, or they failed to return the posttreatment questionnaire (Fig 1). Consequently, the data from 85 patients were included in the analysis (89% female, mean age ± standard deviation [SD] = 41.2 ± 14.5). Baseline descriptive data of these participants are displayed in Table 1. During the follow-up phase, another 15 patients dropped out due to the study's time demands, loss of addresses after address change, or emigration. Baseline characteristics were not significantly different between the 26 dropouts and the 70 study participants who completed the entire study.

As shown in Figs 2 and 3, the mean CPI and MFI values had dropped markedly after completion of treatment. The influence of potential prognostic factors upon the time courses of the two outcome variables during follow-up was analyzed using univariate linear growth models with only one prognostic factor (predictor) in the model at the time (univariate analysis; Table 2). The values of the outcome variables at baseline ($CPI_{baseline}$ or $MFI_{baseline}$), age (for MFI only), the parafunctions score, and the presence of pain elsewhere significantly influenced the initial statuses of the models, viz, the predicted outcome variables at the beginning of the follow-up period (significant b_{01} values), whereas the predictor somatization significantly influenced the slopes of the univariate CPI and MFI models (significant b_{11} values).

The factors having a significant effect upon the initial status or the slope of the univariate linear growth models were also entered into the initial status or slope terms of the final multivariate linear growth models for CPI and MFI (Table 3). Baseline values of the CPI had a positive influence upon its initial status ($b_{02} = 0.270$; $P = .002$), whereas the influences of reported parafunctions (b_{03}) and of

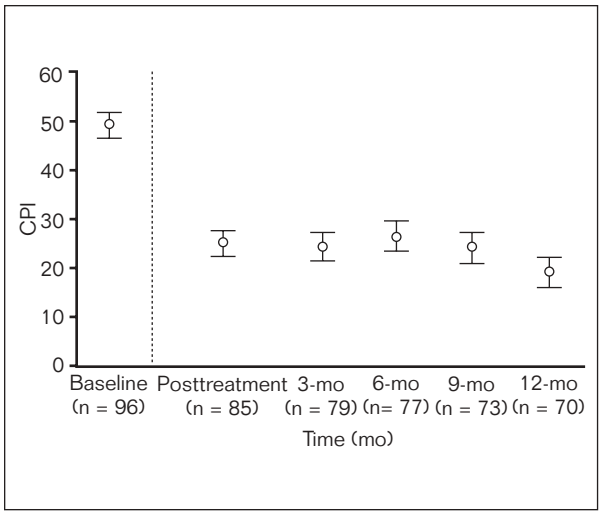

Fig 2 The CPI scores recorded at baseline and during the 12-month period following treatment. CPI scores during follow-up were used in the analyses. Error bars represent standard error (SE) of the mean.

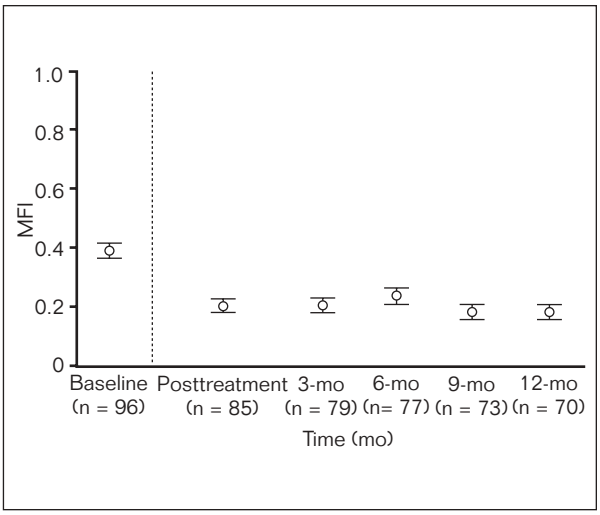

Fig 3 The MFI scores recorded at baseline and during the 12-month period following treatment. MFI scores during follow-up were used in the analyses. Error bars represent SE of the mean.

pain elsewhere (b_{04}) on the initial status were close to significance (*P* value of .058 and .06, respectively). Patients with a low score for somatization (score 0) showed, on the average, a decline of –1.73 in their CPI scores between subsequent readings (*P* = .027). On the other hand, patients with a high score for somatization (score 1) showed an increase of –1.73 + 3.47 = 1.74 (ie, $b_{10} + b_{15}$) between subsequent readings (b_{15} = 3.47; *P* = .030). The baseline values of the MFI also showed a positive correlation with its initial status (b_{02} = 0.315; *P* = .000). The influence of reported parafunctions on the initial status of the MFI was not significant anymore (*P* = .174), but that of the pain elsewhere was (b_{04} = 0.087; *P* = .004). For patients with a low score on somatization (score 0), there was a trend for a further decline in MFI values during follow-up (*P* = .063). For patients with a high score on somatization (score 1), there was a significant increase of 0.032 between subsequent readings (*P* = .007).

When the analyses were rerun with depression and somatization as continuous measures, using the centered, total sum scores instead of their dichotomized values, the univariate results remained the same. However, in the multivariate analysis for CPI, the statistical significance of the coefficient b_{10} no longer reached significance (*P* = .091).

Discussion

It is well known that myofascial TMD pain complaints may show periods of flare-ups or remission.[10] As a consequence, patients participating in a follow-up study may show exacerbation of complaints, whereas, at the same time, others may show diminishing complaints or no complaints at all anymore. This asynchrony in the natural course of myofascial TMD pain complaints between patients may compromise the results of longitudinal studies of the time course of the disorder. Preferably, prognostic studies have a cohort of patients who are in a similar stage of their disease.[11] In the present study, patients were followed who had just undergone a conservative (reversible) treatment for their TMD complaints. At the end of treatment, most patients had achieved an improvement of their symptoms, as indicated by the decrease in the CPI and MFI scores compared to baseline. This indicates that, after completion of treatment, the individual time courses of the myofascial TMD pain complaints were better synchronized than they were before treatment.

The CPI and MFI scores obtained during the 12-month follow-up period following treatment were analyzed using conditional linear growth models.

Table 2 Univariate Analyses with CPI and MFI as Outcome Variables

	CPI scores							MFI scores						
	Initial status			Slope				Initial status			Slope			
	b_{00} (SE)	*P*	b_{01} (SE)	*P*	b_{10} (SE)	*P*	b_{11} (SE)	*P*	b_{00} (SE)	*P*	b_{01} (SE)	*P*	b_{10} (SE)	*P*	b_{11} (SE)	*P*
Age	25.60 (2.45)*	.000	–0.11 (.17)	.525	-3.63 (2.26)	.111	0.06 (.05)	.223	.206 (.019)*	.000	0.002 (.001)*	.079	0.008 (.016)	.612	-0.001 (.001)	.433
Gender	24.79 (2.55)*	.000	6.40 (8.27)	.441	-1.32 (.72)	.188	3.41 (2.34)	.148	.209 (.020)*	.000	-0.032 (.065)	.626	-0.005 (.005)	.353	0.011 (.017)	.513
Pain chronicity	25.62 (2.42)*	.000	0.02 (.05)	.680	-1.19 (.69)*	.090	0.01 (.01)	.754	.207 (.019)*	.000	0.001 (.001)	.578	-0.004 (.004)	.405	0.001 (.001)	.799
$CPI/MFI_{baseline}$	25.20 (2.29)*	.000	0.34 (.09)*	.000	-1.00 (.70)	.158	-0.02 (.03)	.526	.202 (.017)*	.000	0.361 (.081)*	.000	-0.004 (.005)	.404	-0.033 (.023)	.161
Parafunctions	26.06 (2.39)*	.000	33.1 (16.0)*	.041	-1.00 (.72)	.167	1.13 (4.89)	.818	.208 (.019)*	.000	0.283 (.127)*	.028	-0.003 (.005)	.584	-0.004 (.034)	.908
Depression	25.18 (2.58)*	.000	0.62 (3.59)	.864	-1.57 (.80)*	.073	2.30 (1.60)	.154	.207 (.020)*	.000	-0.002 (.024)	.440	-0.007 (.006)	.199	0.014 (.011)	.215
Somatization	25.56 (2.68)*	.000	-0.62 (6.28)	.922	-1.81 (.74)*	.017	4.03 (1.70)*	.020	.208 (.021)*	.000	-0.008 (.048)	.870	-0.011 (.053)*	.041	0.035 (.012)*	.005
Pain elsewhere	22.41 (2.98)*	.000	9.62 (4.44)*	.032	-1.15 (.94)	.221	0.38 (1.38)	.786	.188 (.023)*	.000	0.093 (.034)*	.007	-0.001 (.006)	.915	-0.007 (.009)	.446
Previous treatments	23.81 (3.59)*	.000	4.63 (4.70)	.326	-0.76 (1.04)	.466	-0.38 (1.35)	.779	.203 (.028)*	.000	0.007 (.037)	.855	-0.006 (.007)	.435	0.003 (.009)	.716

The fixed effects estimates, SE, and significance values (*P*) are shown for the nine potential prognostic factors respectively. * = significant at $P < .1$

This method is particularly useful in providing detailed information on how a variable changes over time in an individual patient as well as for a group of patients. In addition, factors that influence these changes can be studied. However, longitudinal studies often provide data that are skewed and marked by an abundance of zero values. For data with many zero values, transformations will not help, as no transformation will change the fact that so many scores have the same value (ie, zero).[12] Although the maximum likelihood method, upon which the linear growth modeling was based, assumes that the residuals are normally distributed, violation of normality does not lead to biased estimates when large samples of at least 50, preferably 100, are being used.[9,13] A key feature of growth modeling is that it enables the inclusion of both fixed effects (eg, gender and baseline values) and random effects into the initial status and rate of change. Another important feature of growth models is that they can cope with missing data sets as long as they are missing at random.[9,13] Although dropouts and incidentally missing questionnaires are frequently encountered in longitudinal questionnaire studies,[14,15] the applied analysis technique makes use of all the collected data, including patients with an incomplete data set. Thus, data of the patients with randomly missing questionnaires and of the 15 patients with an incomplete data set due to dropout during the follow-up, were not removed from the analyses. Since the 26 dropouts did not differ from the 70 completers in any of the baseline characteristics under investigation, the missing values had probably little or no influence on the generalizability of the present findings.

The present results revealed an almost similar time course for the CPI and MFI scores during follow-up and also almost identical predictive factors associated with these time courses. This supports the notion that myofascial TMD pain and impaired jaw function are closely related.[3,16] Patients with higher baseline scores on CPI and MFI reported higher follow-up scores. A report of pain elsewhere in the body at baseline also tended to be associated with higher CPI and MFI scores during follow-up. This corroborates with recent knowledge on the relationship between wide spread pain (eg, fibromyalgia) and TMD (see the review by Fricton[17]). A positive, almost significant relationship was observed between reported parafunctional activities and the follow-up CPI scores. Both positive and negative relationships between oral parafunctions and myofascial TMD pain have been reported in the literature, indicating that the

Table 3 Multivariate Analyses with CPI and MFI as Outcome Variables

	CPI			MFI		
Effect	Coefficient	SE	*P*	Coefficient	SE	*P*
Initial status						
b_{00}	22.48	2.77*	.000	0.165	0.020*	.000
Age, b_{01}	-	-	-	0.002	0.001	.154
$CPI/MFI_{baseline}$, b_{02}	0.27	0.086*	.002	0.315	0.071*	.000
Parafunctions, b_{03}	26.49	13.76	.058	0.146	0.107	.174
Pain elsewhere, b_{04}	7.58	3.99	.060	0.087	0.029*	.004
Slope						
b_{10}	–1.73	0.77*	.027	–0.011	0.006	.063
Somatization, b_{15}	3.47	1.57*	.030	0.032	0.011*	.007

Fixed effects coefficients, SE, and significance values (*P*) are shown. * = significant at $P < .05$.

existence of a causal relationship between the two is still unclear.[18–20] Interestingly, studies that use self-report measures[21–24] seem to yield more often positive relationships between oral parafunctions and pain than studies using instrumental techniques.[25–27] Perhaps persons with pain in the orofacial region have a tendency to overestimate their parafunctional activities.

The majority of myofascial TMD patients in this study showed no signs of an increase of complaints during the 12-months following treatment. Rather, there was a trend of further remission of complaints for patients with a low score on somatization at baseline. Only for patients who scored high on the somatization scale at baseline was there a gradual relapse of complaints during the follow-up period. This finding is in line with the results of a 5-year follow-up study by Rammelsberg et al,[28] in which a high baseline score on somatization showed to be a significant risk factor for the redevelopment of myofascial TMD pain complaints during follow-up. Apparently, psychological factors such as somatization not only play a role in the etiology of TMD myofascial pain,[20,29] but they are also involved in the recurrence of complaints.

Some limitations and qualifications of the study should be noted. Since this study aimed at identifying baseline patient characteristics that are related to the 12-month time course of myofascial TMD pain complaints, factors that were not available prior to treatment, such as treatment length and treatment type, were not included in the analyses. Due to the differences in treatment length, the time span between baseline and the 12-month follow-up period varied between participants. A further potential limitation of the present study concerns the possibility that some of the posttreatment changes may have been due to the continued use of medication or occlusal splint during the follow-up period. Finally, the two psychological measures were dichotomized at the 80th percentile with relatively few participants having a score of 1. Although this dichotomization might have influenced the outcome due to a loss of power, the use of continuous psychological measures almost did not change the outcome. This suggests that dichotomized psychological measures can be used for patient screening.

In conclusion, baseline reports of pain and impairment, oral parafunctional activities, pain elsewhere in the body, and somatization are associated with the severity and time course of myofascial TMD pain complaints following treatment.

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