Short-term Clinical Outcomes and Patient Compliance with Temporomandibular Disorder Treatment Recommendations

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Aims: *To evaluate short-term patient compliance with 5 conservative temporomandibular disorder (TMD) treatments (jaw relaxation, jaw stretching, heat application, cold application, and occlusal splint use) and the association of compliance with changes in pain intensity, pain-related activity interference, and jaw use limitations.* ***Methods:*** *Eighty-one TMD patients were given 1 to 5 treatment recommendations as part of usual care in a TMD specialty clinic. Compliance with each recommendation and pain, pain-related activity interference, and jaw use limitation measures were calculated from electronic interviews conducted 3 times daily for 2 weeks.* ***Results:*** *Median compliance with individual treatment modalities ranged from 7.7% for heat application to 92.7% for jaw relaxation; median overall compliance was 54.8%. Participants with higher initial pain intensity and jaw use limitations were significantly more compliant with their recommended treatment regimen ($P < .05$). The authors controlled for age, gender, education, and initial jaw use limitations. Overall compliance was associated significantly and positively with 2-week jaw use limitations ($P = .03$). A trend toward a statistically significant positive association was found between compliance and 2-week pain intensity ($P = .09$).* ***Conclusion:*** *Compliance varied widely across patients and therapies. Patients with higher initial pain and jaw use limitation levels were more compliant with treatment recommendations. Although compliance was associated with slight increases in pain and jaw use limitations in this preliminary study, further research is needed to evaluate the longer-term effects of compliance with recommended therapies.* J OROFAC PAIN 2004;18:203–213

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Temporomandibular disorders (TMD) are an interrelated but heterogeneous set of conditions usually characterized by pain in the preauricular area, temporomandibular joint (TMJ), or masticatory muscles; limitation in vertical range of mandibular motion; and noise in the TMJ during mandibular function. TMD are the most common type of facial pain problem,[1] with an estimated prevalence of 10% to 12%.[2–4] Approximately 6% of the population seeks treatment annually for orofacial pain.[5,6] Despite the growing research literature, however, the etiologies of the most common forms of chronic TMD are poorly understood.[7–10] As a result, no single treatment is currently adopted as standard.[11–13]

TMD treatment generally focuses on relieving symptoms rather than curing the underlying problem. Occlusal splints, one of the most widely utilized TMD treatments, have been reported to reduce acute pain for 70% to 90% of patients,[14] but their efficacy continues

to be debated because the few available randomized controlled trials (RCTs) generally are of low quality and do not include long-term follow-up.[12,13] Other treatments, such as progressive muscle relaxation training and electromyographic biofeedback, have been applied based on the premise that reducing masticatory muscle tension will decrease dysfunction and pain.[15–21] As long as no connective tissue tearing occurs, slow stretching is similarly believed to result in muscle relaxation[22] and thus pain reduction. Thermal therapy, both alone[22] and in combination with stretching,[23] has also been shown to relieve muscle pain and inflammation.

Regardless of treatment modality, however, patient adherence to provider recommendations is thought to improve outcomes.[24] Adherence, or compliance, has been defined as "the extent to which a person's behavior (in terms of taking medications, following diets, or executing lifestyle changes) coincides with medical or health advice."[25] A recent meta-analysis found the odds of a favorable outcome across multiple medical conditions and treatments to be 3 times higher for patients adherent to treatment recommendations than for noncompliant patients.[26] This positive association between compliance and clinical improvement is seen even for compliance with placebo.[27]

Unfortunately, rates of noncompliance with therapeutic regimens have been estimated to range between 30% and 60%.[28] Within dentistry, the widespread problem of noncompliance is evidenced by the most prevalent dental problems, caries and periodontal disease, resulting mainly from poor oral hygiene.[29] Only about 30% of periodontal patients are completely compliant with supportive periodontal treatment maintenance schedules.[30,31] Only 4% of orthodontic patients indicate complete compliance with wearing headgear, intraoral elastics, or other appliances as recommended.[32] Half of patients are reported to be less than highly compliant with even simple oral hygiene instructions.[33]

Similarly, low compliance has been observed among patients receiving treatment for chronic pain. Within a multidisciplinary pain management program, chronic pain patients who had not responded to previous medical interventions were on average 42% compliant with individual home-based therapies.[34] Daily compliance was highest (52%) for physical and occupational therapy exercises and lowest (20%) for treatments that required special equipment (eg, ice packs and electrical stimulation). Compliance with the complete recommended therapeutic regimen was only 12%. In a study of patients evaluated at a facial pain clinic, rates of self-reported receipt of the recommended treatments ranged from 50% for surgery to 93% for medication change.[35] Whitney and Dworkin[36] found a compliance rate of 69% among TMD patients assigned to a 2-session cognitive-behavioral intervention in an RCT, where compliance was defined as attendance at both sessions and completion of all follow-up assessments. However, this study did not examine patient compliance where compliance was defined as performance of specific treatment recommendations. We could not identify any prospective studies of TMD patient compliance with dentist-recommended therapies or of the relationship between patient outcomes and compliance with specific therapies.

To address this gap in the literature, we evaluated short-term patient compliance with 5 commonly recommended conservative TMD treatments (jaw relaxation, jaw stretching, heat application, cold application, and occlusal splint use) and the association of compliance with changes in 3 important TMD outcomes: pain intensity, pain-related activity interference, and jaw use limitations. These variables were measured via daily electronic diary methodology, which is subject to less recall bias compared with more traditional methods of retrospective assessment.[37,38] We hypothesized that greater compliance with dentist-recommended treatments would be associated with better outcomes on all 3 measures.

Materials and Methods

Participants

Study participants were patients seeking care at the University of Washington Department of Oral Medicine Orofacial Pain and Temporomandibular Disorders Clinic (UW TMD Clinic) and enrolled in an RCT comparing usual care in the clinic plus either a TMD self-care manual (SCM) or 4 cognitive-behavioral pain management training (PMT) sessions. All data in this report were collected during the study baseline phase before participants attended the first session of the treatment to which they were randomized.

Inclusion criteria were

- Age 18 years or older
- The ability to complete the study measures
- Residence within a 2-hour driving distance of the UW TMD Clinic
- A Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I TMD pain diagnosis[10]

- TMD pain for at least 3 months
- Pain-related disability as defined by a Graded Chronic Pain Scale (GCPS) chronic pain grade of II high (high pain and low pain-related disability), III (moderate disability), or IV (severe disability)[39–41]

Exclusion criteria (assessed by patient questionnaire and the patient's TMD specialist) included

- Significant oral mucosal lesions or atypical TMD findings requiring further diagnostic evaluation
- Pending litigation or disability compensation for pain
- Major medical or psychiatric conditions (eg, clinical indications for surgical treatment, major medical illness, psychosis, active suicidal ideation, or current alcohol or substance abuse)
- Prior participation in research involving cognitive-behavioral treatment for TMD

All new clinic patients eligible for the study were invited to participate. The study was approved by the University of Washington's institutional review board, and all participants provided written informed consent. Participants were not told that their compliance with treatments would be assessed.

Of the 244 patients identified as eligible, 110 (45%) enrolled in the study. The primary reason given for declining to participate was the time required for the 4 intervention sessions. Of the 110 participants, 9 did not complete any daily electronic interviews because they dropped out of the study soon after enrolling, 12 had fewer than 12 days of interview data before the first study intervention session for a variety of reasons including hardware failure, 6 did not have a treatment checklist completed within 60 days prior to enrollment, 1 did not have a locatable chart, and 1 missed more than 50% of the requested interviews. After the exclusion of these patients, a sample of 81 participants remained. No statistically significant differences were found between subjects included in the analysis (n = 81) and those who were excluded (n = 29) or who refused to participate (n = 134) in age, pain duration, race or ethnicity, sex, pain intensity, or education (*t* test and chi-square analyses).

Procedure and Measures

RDC/TMD Evaluation and Self-care Recommendations. As is standard practice during a patient's first visit to the UW TMD Clinic, an oral medicine facial pain specialist obtained a history and evaluated each patient with the RDC/TMD.[10] At the end of the evaluation, the dentist checked off specific TMD self-care activities recommended for the patient from a structured treatment checklist used by all specialists in the clinic. One copy was given to the patient and another was filed in the patient's chart. Each participant was instructed in 1 or more of the following therapies:

- Jaw relaxation by keeping "jaws relaxed, teeth separated, lips apart" or by "placing tip of tongue behind lower front teeth [and then letting the] tongue go completely relaxed"
- Jaw stretches by "open[ing] as wide as possible without pain. Hold [a specified number of] seconds, close halfway and rest for 5 seconds"
- Cold pack application to areas of pain
- Heat pack application to areas of pain
- Occlusal splint use (either a laboratory-manufactured hard acrylic splint or self-made soft athletic guards)

The recommended frequency for each activity was specified on the checklist and also indicated verbally. Although this frequency varied across treatments and patients, the minimum expected frequency for all activities was once daily.

Pain Intensity and Disability. At baseline, participants completed the GCPS[39,40] and a questionnaire that assessed sociodemographic characteristics. From the GCPS, characteristic pain intensity (CPI) scores were calculated by averaging participant ratings (0 to 10 scale) of current pain, worst pain in the past month, and average pain in the past month, then multiplying by 10. Pain-related disability scores were computed by averaging GCPS ratings (1 to 10 scale) of pain-related interference with daily activities, work/housework activities, and recreational/social activities, then multiplying by 10. The CPI and pain-related disability scores have good internal consistency (.91 and .89, respectively), test-retest reliability (.82 and .85, respectively, over a 1- to 2-week interval), and validity, as evidenced by their associations with other measures of pain severity and disability.[40,42]

Electronic Interviews. Participants received training in the completion of electronic interviews on palm computers. The computers were programmed to sound an alarm 3 times daily at times determined by the participant, with the requirement that the times be at least 3 hours apart and at least 3 hours after awakening in the morning. The alarm sounded every 5 minutes for 45 minutes until the participant responded, at which point the participant could complete the interview or postpone it

for 5, 10, or 15 minutes. If the participant did not complete the interview within 45 minutes of the scheduled interview time, there was no further opportunity to do so. Eight weeks of interviews were conducted, but only those interviews completed before the first study intervention session (SCM or PMT) approximately 2 weeks after beginning the electronic interviews were analyzed for this report to avoid any influence of the study intervention on self-care activity performance. Data analyzed for participants who completed more than 14 days of interviews before the first study intervention session were limited to the first 14 days to ensure a uniform sampling frame.

Each interview included questions concerning participants' performance since the last interview of the recommended self-care activities. Participants were also asked during each interview to rate from 0 to 10 their average TMD pain intensity, how much TMD pain had interfered with their activities, and how limited they had been in their ability to use their jaws during the past 3 hours. Additional questions assessing use of other pain coping strategies, mood, and beliefs about pain were included in each interview but were not analyzed for this report.

Compliance Rates. Each subject's recommended TMD self-care activities were identified from the treatment plan formulated during the initial clinic visit, and the subsequent completion of these activities was assessed through the daily electronic interviews. Rates of compliance with each recommended activity over the 2 weeks were calculated for each subject. For example, if a participant was advised to use heat and replied "yes" to the diary question "application of heat to TMJ" during at least 1 of the 3 interviews on a particular day, the participant was deemed compliant with heat application for that day. The participant's heat application compliance rate over the 2 weeks was calculated as the number of days the participant was compliant divided by the number of days the participant completed at least 1 interview. A compliance rate was computed for each patient for each recommended activity. For all occlusal splint use recommendations, chart review identified the presence of an existing splint, the delivery date of a new splint, and any events preventing splint use. No splints were broken during the study period, but 1 subject discontinued splint use upon the recommendation of her primary care provider and 4 subjects did not receive their splint within the study period. The compliance rate for splint use was calculated based on the number of data collection days during which splint use was possible.

Daily overall compliance rates were calculated for each participant as the percent of recommended activities completed at least once that day. For example, if a participant reported completing 4 of 5 recommended activities at least once in a particular day, the participant was deemed 80% compliant for that day. Daily compliance rates were averaged over the 2-week study period to produce an overall compliance rate for each participant.

Statistical Analysis

Initial and 2-week pain intensity, pain-related activity interference, and jaw use limitation levels were calculated as the mean of the ratings in the first 3 interview days and in the last 3 interview days, respectively. The associations between compliance rates and initial pain, activity interference, and jaw use limitation ratings were examined by Pearson correlations. Due to the skewed distributions of the individual treatment compliance rates, these associations were also examined by Spearman's correlation coefficients. The results were very similar; Pearson's coefficients are presented in the tables so that they may be compared to the results of the regression analyses. Linear regression analyses were used to examine whether overall compliance was associated with 2-week pain, pain-related activity interference, or jaw use limitations, after controlling for initial levels of these outcome measures and for factors that could affect compliance and outcomes (age, gender, and education level). No compliance variable was associated significantly with the number of days between treatment checklist receipt and first electronic interview ($-0.19 \leq r_s \leq 0.10$). Therefore, no adjustment was made for this interval in the analyses. Finally, analyses of variance and *t* tests were used to examine whether compliance was associated with patient age, education, gender, race, or time since first onset of facial pain. The conventional alpha level of 0.05 was used for all statistical tests.

Results

Patient Characteristics

The 81 study participants on average completed 13.6 days of interviews (standard deviation [SD] = 0.68), began the electronic interviews 14.4 days (SD = 12.3) after receiving their treatment plan, and completed 87.7% (SD = 11.5%) of the requested interviews over the 2 weeks. Participants' baseline demographic and clinical characteristics are

summarized in Tables 1 and 2. The average age was 38.4 years (SD = 11.6, range = 19 to 68 years), and most participants were female (85.2%) and Caucasian (84.0%). The sample was characterized by chronic and severe facial pain. TMD pain first began a mean of 6.7 years prior to study enrollment (SD = 7.8 years, range = 3 months to 43 years) and the mean CPI score was 71.0 (SD = 14.7).

TMD Treatment Recommendations and Compliance

Table 3 summarizes the treatment recommendations and patient compliance. Jaw relaxation was prescribed for almost all of the participants (98%), whereas heat application was the least frequently prescribed regimen (35% of the patients). Splint therapy was recommended for almost half (46%) of the study participants. Compliance varied widely across the recommended treatment modalities, with the highest rate for jaw relaxation (mean = 79.8%, median = 92.7%) and the lowest for heat application (mean = 30.5%, median = 7.7%). The mean overall compliance rate was 54.2% (SD = 26.5%, range = 0% to 100%, median = 54.8%).

Most patients were given either 3 (n = 34, 42.0%) or 4 (n = 31, 38.3%) treatment recommendations. The most common combinations were jaw relaxation, jaw stretching, cold application, and splint use (n = 21, 25.9%) and jaw relaxation, cold application, and heat application (n = 13, 16.0%). Three patients (3.7%) received only 1 recommendation (either jaw relaxation or splint use), whereas 2 patients (2.5%) received all 5 treatment recommendations. Eleven patients (13.6%) received 2 recommendations, the most prevalent combination of which was jaw relaxation plus splint use (n = 5, 6.2%). With respect to thermal therapies, 43 patients (53.1%) were advised to apply cold but not heat, 3 patients (3.7%) were

Table 1 Demographic Characteristics of the Study Participants (n = 81)

Treatment	n	%
Gender		
Female	69	85.2
Male	12	14.8
Ethnic/racial groups		
White	68	84.0
Asian	5	6.2
Hispanic	3	3.7
American Indian/Alaskan native	2	2.5
Other	3	3.7
Highest education level completed		
Some high school	3	3.7
High school	14	17.3
Some college	32	39.5
College	17	21.0
Graduate/professional school	15	18.5
Marital status		
Married	39	48.1
Never married	26	32.1
Separated, divorced, or widowed	16	19.8

Table 2 Baseline Clinical Characteristics of Study Participants (n = 81)

Characteristic	Mean	SD	n	%
Chronic pain grade				
II high (high pain intensity and low pain-related disability)			24	29.6
III (moderate pain-related disability)			22	27.2
IV (severe pain-related disability)			35	43.2
RDC/TMD diagnosis*				
Myofascial pain (Ia)			34	42.0
Myofascial pain with limited opening (Ib)			43	53.1
Disc displacement with reduction (IIa)			13	16.0
Disc displacement without reduction, with limited opening (IIb)			5	6.2
Disc displacement without reduction, without limited opening (IIc)			2	2.5
Arthralgia (IIIa)			44	54.3
Osteoarthritis of the TMJ (IIIb)			5	6.2
Osteoarthrosis of the TMJ (IIIc)			0	0.0
Time since initial onset of pain (y)	6.7	7.8		
Duration of current pain episode (y)	3.8	7.2		
Characteristic pain intensity (scale of 0 to 100)	71.0	14.7		
Pain-related disability score (scale of 0 to 100)	58.1	20.3		

*Some patients had multiple diagnoses.

Table 3 Treatment Recommendations and Patient Compliance Rates

Treatment recommendation	No. of patients receiving recommendation (%)	Compliance rate (%)*		
		Mean	SD	Median
Jaw relaxation	79 (97.5)	79.8	30.2	92.7
Jaw stretching	45 (55.6)	64.9	33.4	69.2
Cold application	68 (84.0)	31.2	33.2	14.8
Heat application	28 (34.6)	30.5	35.2	7.7
Splint usage	37 (45.7)	43.0	39.9	42.9
Overall treatment plan	81 (100.0)	54.2	26.5	54.8

*Among patients for whom the treatment was recommended.

Table 4 Pearson Correlations Between Compliance Rates Over 2 Weeks and Initial Pain Intensity, Activity Interference, and Jaw Use Limitations

Treatment compliance	Pearson correlation		
	Pain intensity	Activity interference	Jaw use limitations
Jaw relaxation (n = 79)	0.12	0.06	0.11
Jaw stretching (n = 45)	0.12	0.08	0.07
Cold application (n = 68)	0.34**	0.17	0.27*
Heat application (n = 28)	0.21	0.17	0.35
Splint usage (n = 37)	0.03	0.03	0.06
Overall treatment plan (n = 81)	0.24*	0.15	0.23*

*$P < .05$.
**$P < .01$.

advised to apply heat but not cold, and 25 patients (30.9%) were advised to use both therapies. There was no relationship between the number of treatment recommendations received and overall compliance (r_s (79) = –0.01, P = .96).

Distributions of the individual treatment compliance rates were skewed. The distributions of compliance with jaw stretching and jaw relaxation were negatively skewed, with almost half (46.8%) of those advised to engage in jaw relaxation and almost one third (29%) of those advised to perform jaw stretching being 100% compliant. In contrast, compliance with both thermal therapies was positively skewed. Over one fourth of those advised to use cold or heat packs were 0% compliant (26.5% and 35.7% of patients, respectively). Splint use compliance had a bimodal distribution; almost a third (29.7%) of patients were at least 90% compliant whereas another third (37.8%) were less than 10% compliant. Splint compliance was significantly higher for patients with existing splints than for those receiving new splints (mean [SD] = 66.2% [36.2%] versus 35.6% [38.8%], t(35) = -2.09, P = .04). The distribution of overall compliance with all treatment recommendations was approximately normal.

Association Between Compliance and Pain, Activity Interference, Jaw Use Limitations, and Patient Characteristics

Table 4 shows the Pearson correlations between compliance rates and initial pain, activity interference, and jaw use limitation levels. Overall compliance over the 2 weeks was significantly and positively associated with initial pain intensity (r = 0.24, P = .03) and jaw use limitations (r = 0.23, P = .04), suggesting that participants with higher levels of pain and jaw use limitations, but not pain-related activity interference, were more likely to perform the dentist-recommended self-care treatments. Inspection of the correlation coefficients for compliance with individual treatments revealed that participants with greater initial pain and jaw use limitations were significantly more likely to be compliant with the application of cold. Although the Pearson correlation of initial jaw use limitations with heat application was 0.35, this relationship was not statistically significant, partly because so few participants (n = 28) were advised to use heat.

For descriptive purposes, initial pain, 2-week pain, activity interference, and jaw use limitation ratings are summarized in Table 5. As can be seen,

there was little change on average. The regression analyses are summarized in Table 6. Although most of the variance in 2-week jaw use limitation ratings, after controlling for age, gender, and education level, was explained by initial jaw use limitations (R^2 change = 0.67, $P < .001$), higher overall compliance was associated with significantly higher 2-week jaw use limitation ratings (R^2 change = 0.02, $P = .03$; unstandardized coefficient = 0.01, $P = .03$). Similar trends were seen in the regression model predicting 2-week pain intensity ratings. After we controlled for the demographic variables and initial pain ratings, compliance showed a trend toward statistical significance (unstandardized coefficient = 0.01, $P = .09$) and explained a very modest additional 1% of the variance in 2-week pain intensity ratings. Compliance was not a statistically significant predictor of 2-week activity interference when the demographic variables and initial activity interference were controlled.

Finally, the association between selected baseline patient characteristics and compliance was examined. Overall compliance was not significantly associated with time since the first onset of facial pain (comparison of ≤ 1, 1 to 3, 3 to 10, and > 10 years: $F[55, 23] = 1.52$, $P = .14$), age ($r = 0.05$, $P = .65$), education (comparison of high school or less, some college, and college or graduate degree: $F[2,77] = 1.38$, $P = .26$), gender ($t[79] = .19$, $P = .85$), or race (Caucasian versus other: $t[79] = .58$, $P = .57$).

Discussion

Greater initial pain and jaw use limitations predicted significantly higher patient compliance. TMD patients with more severe symptoms would be expected to be more motivated to relieve symptoms and thus more likely to comply with treatment recommendations. These results are consistent with those of a previous study of chronic facial pain patients that found that greater pain at initial clinic evaluation predicted higher overall treatment

Table 5 Mean Initial and 2-Week Pain Intensity, Activity Interference, and Jaw Use Limitation Ratings (n = 81)

	Initial score*		2-Week score*	
	Mean	SD	Mean	SD
Pain intensity	4.5	2.0	4.3	2.3
Activity interference	2.6	1.9	3.0	2.3
Jaw use limitations	3.0	2.2	3.2	2.4

*Scale from 0 to 10.

Table 6 Predictors of 2-Week Outcomes

	Coefficient	SE	*P*	R^2	$P^\dagger$
Pain intensity					
Demographics				0.07	.24
Age	–0.03	0.01	.03		
Gender	–0.31	0.40	.44		
Education*					
Some college	–0.07	0.38	.85		
College graduate	0.26	0.39	.52		
Initial pain intensity	0.94	0.07	< .001	0.73	< .001
Overall compliance	0.01	0.01	.09	0.74	.09
Actvity interference					
Demographics				0.07	.19
Age	–0.03	0.01	.04		
Gender	–0.41	0.44	.35		
Education*					
Some college	0.35	0.43	.42		
College graduate	0.34	0.43	.44		
Initial activity interference	0.98	0.09	< .001	0.68	< .001
Overall compliance	0.01	0.01	.23	0.68	.23
Jaw use limitations					
Demographics				0.08	.19
Age	–0.04	0.01	.005		
Gender	–0.21	0.40	.60		
Education*					
Some college	0.47	0.38	.22		
College graduate	0.55	0.39	.16		
Initial jaw use limitations	0.90	0.07	< .001	0.75	< .001
Overall compliance	0.01	0.01	.03	0.77	.03

*Reference: high school or less.
†For R^2 change.

compliance.[35] However, contrary to our hypothesis, higher overall compliance with dentist-recommended treatments over a 2-week period was associated with increased, rather than decreased, jaw use limitations after controlling for demographic variables and initial jaw use limitations. This association was statistically significant but very small and therefore of questionable clinical significance. A similar trend, although not statistically significant, was seen for pain intensity. These findings are surprising given the literature on the subject.[27]

Several possible explanations exist for the lack of an association between patient compliance and symptom improvement. First, the efficacy of the dentist-recommended treatments, despite their widespread application in TMD treatment, has not been established in RCTs. However, given previous findings of relationships between compliance and better outcomes, patients who are more compliant might be expected to show improved outcomes regardless. It is highly plausible that a 2-week period is not sufficient time to realize improvement in pain and functioning, especially given the chronic nature of these patients' conditions. In fact, the data showed little overall change in the 3 outcome measures over the 2-week study period, and the strong association between initial and 2-week outcomes left little additional variance to be explained by other variables. In previous studies, the duration of treatment before outcome assessment has varied considerably. The time to clinically significant improvement may vary across treatments as well as patients; failure to allow sufficient time to elapse before outcomes are measured can lead to incorrect conclusions.

Other explanations are also possible. First, compliance with other treatments, most notably medications, was not assessed but may have affected patient outcomes. Second, after initiating a treatment modality, some symptoms may immediately worsen before any improvement can be seen. For example, after beginning some therapies such as stretching and splint use, the masticatory muscles may first react negatively, leading to a short-term increase in pain before improvement can be seen. Third, more compliant patients may be more aware of their symptoms. Patients who focus frequently on the need to perform stretches, relaxation, etc, may concentrate more on their symptoms as well, which might increase perceived symptom intensity. Previous studies have documented both increases in reported pain and changes in the brain's processing of painful information when greater attention is directed toward pain.[43,44] Fourth, many TMD patients cycle through pain episodes and seek treatment when pain begins to worsen. For such patients in this study, the 2-week study period may have corresponded to a time when pain levels were increasing.

This study adds to the scant literature concerning compliance with specific treatments among TMD patients seeking care at a specialty clinic. Compliance rates have been reported previously for only 1 of the 5 treatments that were evaluated (splint therapy). Among a sample of chronic facial pain patients,[35] 60% reported that they were advised to use splint therapy (versus 46% in the present study sample) and 90% of these said that they received a splint. In the present study, 70% of those who were recommended a splint and had 1 available wore it at least once; on average these patients used their splint on 43% of the days in the study period. Differences in how compliance was defined might explain apparent differences in compliance rates reported across studies. In the Riley et al study,[35] patients who reported receiving a splint during the 8 months following initial evaluation were considered compliant with the recommendation for splint use, whereas in the present study compliance was defined as the percentage of days that patients reported using their splint in a 2-week period.

The higher splint compliance for existing versus new splint users is notable, and several explanations are possible. First, existing splint users were likely patients who had perceived benefit from prior splint use and therefore established a pattern of regular use which continued during the study. Among patients receiving a new splint, some may have experienced increased symptoms that they associated with splint therapy and therefore discontinued wearing the appliance. Furthermore, patients just beginning splint therapy may not have developed a regular pattern of use. Finally, patients advised to use new self-made soft athletic guards may have encountered construction difficulties at home that resulted in a poorly fitting appliance, which may have reduced compliance. A similar comparison between existing and new users of the other therapies studied was not feasible with the current data set; this would be of interest to explore in future studies.

Of interest is the wide variation in compliance with specific treatment recommendations across both patients and treatment modalities. Differences in compliance rates across treatment modalities may be a function of the treatment complexity and the degree of effort required; both factors have been noted previously to be associated negatively with compliance.[45,46] For example, jaw relaxation,

the activity for which compliance was highest, requires no special equipment and can be done anywhere at any time. On the other hand, much lower compliance was observed for application of cold and heat, both of which require more time, materials, and effort, and cannot be performed in all locations. Similarly, in a study of patients participating in multidisciplinary pain treatment, compliance rates for ice pack application and electrical stimulation were the lowest among the treatments examined.[34]

The findings should be considered in light of the patient population from which the sample was drawn. In general, these patients had been referred to the UW TMD clinic because of chronic pain that had been unresponsive to previous treatment. These patients may have been less likely to be compliant with recommended treatments that they had previously tried and found unhelpful. Further, prior lack of a positive response to treatments may have decreased the patients' belief in the efficacy of any new conservative treatment, thereby serving to reduce their compliance with any new recommendation. Finally, patients were only included in this study if they had severe and disabling pain; this patient population is characterized by high levels of psychosocial dysfunction, which may interfere with patients' ability to benefit from TMD treatment.[41]

The results suggest potentially useful clinical implications for dentists who treat TMD patients. It may be helpful to inform patients that short-term lack of improvement, or even slight worsening of symptoms, should not be a source of discouragement. Such outcomes are not necessarily an indication that the treatment will not work or is harmful over the long term, but rather may be necessary to endure prior to experiencing relief. For example, with regard to thermal therapies, TMD patients have been reported to have low thermal pain threshold and tolerance levels.[47] If so, application of cold or heat may cause a transient increase in symptoms until the muscle becomes fully warmed or chilled. Unless patients are willing to tolerate this initial spike in symptoms, the benefits of thermal therapy may never be realized; in ice therapy, the optimal 10 to 15°C temperature reduction in both the superficial and deep tissue layers requires application for approximately 10 minutes.[48,49] As a result, it is not surprising that compliance rates for the application of cold and heat were the lowest of all treatments studied (median rates of 14.8% and 7.7%, respectively), and that so many of those advised to use cold and heat never did so (26.5% and 35.7% of patients, respectively).

In the absence of clinical "red flags," dentists should not be alarmed or discouraged if patients report no improvement or mild worsening of symptoms in the first few weeks of conservative treatment. Patients who perform stretching exercises too aggressively and experience an increase in pain may be advised to stretch less aggressively. On the other hand, sudden or progressive restriction in opening is suggestive of a disc displacement, progressive joint pathology, or muscle spasms.

Several limitations of this study should be noted. First, the enrollment rate (45%) was low, and 29 subjects were excluded from data analyses due to missing information. Furthermore, the sample was selected for high levels of pain and disability. The generalizability of the study findings to all TMD patients seen in specialty clinics and to TMD patients in other settings (eg, general dental practitioners' offices) needs to be ascertained in future studies; it is unknown whether the current study participants were more or less compliant than patients in other settings. Second, being asked in the electronic interviews whether the therapies were used recently may have increased subject use of the therapies. Previous studies on the reactivity of daily diary methodology, however, have found no evidence to support the presence of this effect.[38,50,51] Third, other commonly recommended treatments such as medications were not included in the study. Fourth, because of missing interviews and the timing of interviews, some inherent error exists in the compliance rate calculations. Unless the recommended activity was performed before a completed interview, the participant was not considered compliant even if he or she actually completed the activity that day. Fifth, these standardized interviews did not allow for the assessment of compliance with the frequency of therapy use recommended for each patient, and the minimum requested frequency (once per day) was applied to all recommendations for all patients. As a result, we were unable to assess, for example, whether more frequent jaw relaxation (multiple times daily) was associated with better outcomes.

Strengths of this study should also be highlighted. Compliance was assessed by date- and time-stamped electronic interviews 3 times a day. Thus, inaccuracies and biases associated with more traditional assessment methods requiring subjects to report on activities over long periods of time (eg, paper diaries, which do not allow researchers to verify when entries were made) were reduced.[38,50,51] Furthermore, because participants were unaware

that treatment compliance would be evaluated, there was no inherent incentive to please the investigators or treating dentists by reporting higher compliance. Finally, the chart review was used to identify which patients received splints and when, so that compliance with splint use could be assessed more accurately.

To the authors' knowledge, this is the first study to evaluate prospectively TMD patient compliance with a range of specific conservative therapies recommended by their dentists. The findings underscore the need for well-designed RCTs that examine the efficacy of specific treatment modalities, relative to both placebo and no treatment, in relieving pain and improving jaw functioning. Research is also needed to determine the duration of treatment necessary to realize optimal gains, mechanisms of therapeutic action, long-term patient compliance with conservative treatments for TMD, and the relationship between compliance and longer-term outcomes. Finally, research is indicated to identify ways to increase patient compliance with scientifically proven treatments. Greater knowledge in these areas will allow dentists not only to educate patients better as to expected results over the course of treatment but also to increase compliance in an effort to improve clinical outcomes for those suffering from TMD.

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