Daily Pain Coping Among Patients with Chronic Temporomandibular Disorder Pain: An Electronic Diary Study

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Aims: To describe patients' daily coping with the pain of chronic temporomandibular disorders (TMD), the conservative treatment received, and the self-care strategies used, and to examine the relationships between these strategies and daily pain intensity, activity interference, and jaw use limitations. *Methods:* TMD clinic patients (n = 137, 88% women) completed electronic diary measures of pain, interference, jaw use limitations, and use of 20 strategies 3 times daily for 2 weeks. *Results:* Reliability and validity were demonstrated for 4 scales of related coping items: cognitive coping, relaxation, activity reduction, and emotional support. Average scores were higher on the relaxation and activity reduction scales than on the cognitive coping and emotional support scales. Among the coping items not included in the scales, "did something to try to reduce pain" (direct action) was endorsed most frequently (reported in a median of 74% of interviews). Heat, cold, and seeking spiritual support were used least ($\leq$ 5%). At times of increased pain, patients were more likely to use almost all types of strategies. Pain intensity was associated strongly with concurrent activity interference and jaw use limitations. When the design controlled for pain intensity, activity reduction and seeking emotional support were associated positively within-subjects with interference and jaw use limitations. *Conclusion:* TMD clinic patients use a variety of treatment, self-care, and coping strategies to contend with daily pain. Inquiring about a broad range of strategies might help clinicians better understand how individual patients approach pain management. Research is needed to examine whether decreasing activity reduction and emotional support coping results in improved outcomes. J OROFAC PAIN 2006;20:125–137

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Temporomandibular disorders (TMD) are a group of conditions typically characterized by facial pain and limitations in jaw functioning.[1] Individuals with chronic TMD pain vary widely in degree of disability and psychosocial distress,[2–4] and objective findings do not appear to account for these differences.[3,5] This suggests the potential importance of nonbiological variables in TMD dysfunction. One such factor may be the way that individuals with TMD respond to, or cope with, their pain.

Studies of patients with various other chronic pain problems have generally found that so-called "passive coping" in response to pain (eg, resting, guarding, seeking emotional support, wishful thinking, or praying/hoping that the pain would go away) is associ-

ated with greater pain, pain-related activity interference, and psychological distress,[6–11] whereas so-called "active" coping, or attempts to manage pain through one's own resources and efforts to function despite pain (eg, task persistence, exercising, attention diversion), generally is associated with lower levels of these variables.[6–9,12] For example, a study of daily coping strategies found that individuals whose coping involved more relaxation efforts had less intense pain, and those who used emotional expression and seeking spiritual comfort described their pain as more intense.[11]

Relatively little research has examined coping strategy use among patients with chronic TMD pain, but the few studies in this area suggest similar findings. For example, passive coping (expression of emotions, wishful thinking) was found to be associated with greater pain and psychological distress,[13] and decreases in passive coping were associated with improvements in pain, jaw vertical range of motion, and depression over a 3-month period.[14] In a more recent study,[15] coping measures explained 13% of the variance in TMD pain-related activity interference after controlling for age, gender, and pain intensity, and praying/hoping was a strategy particularly associated with activity interference.

In addition to using pain-coping strategies such as those already mentioned, patients with TMD pain may also use self-care and conservative treatments recommended by dental clinicians.[16,17] This team of investigators previously reported on compliance with 5 conservative TMD treatment (occlusal splints) and self-care (jaw relaxation, jaw stretching, heat application, cold application) strategies recommended to patients in a TMD clinic,[18] as assessed by daily electronic diaries. However, we did not examine in that study the use of additional pain-coping strategies, which are often used concurrently with dentist-recommended therapies. Examination of the use of a wide range of strategies may be necessary in order to more fully understand how patients' responses to their pain relate to important clinical outcomes. For chronic conditions such as TMD, good self-management may reduce health care costs and patient disability, and improve patient quality of life. Identification of helpful and of unhelpful (or even detrimental) self-management strategies is a critical first step in developing optimal comprehensive treatment approaches. Although randomized controlled trials are the gold standard for establishing the efficacy of a particular strategy, prospective cohort studies can be useful in identifying strategies to test in more methodologically rigorous research.

Of the few studies of pain-coping strategy use in persons with TMD, almost all have used retrospective questionnaire measures of coping administered at a single assessment. Such measures may suffer recall bias, and this methodology can obscure individual differences, as it examines relations at the between-subjects level only.[19] These considerations and the fluctuating nature of pain point to the need to examine coping and pain outcome variables in real time. It may be the case, for example, that coping strategy use varies according to time of day or pain intensity, or that the effects of coping strategy use differ depending upon whether they are examined at the level of the individual over time (ie, "within-subject") or across individuals ("between-subjects" analyses). Such issues may be addressed by the collection of data via electronic daily diaries.[20] Although electronic diary methods have been used to examine the relations between such variables as daily pain, mood, and pain control appraisals among patients with TMD pain,[21] they have not yet been applied to examining use of individual coping and treatment strategies and their relationship to important clinical outcomes.

The overall goal of the current study was to utilize electronic diary methods to increase understanding of TMD clinic patients' use of a variety of strategies to self-manage pain on a daily basis. It was decided not to label coping, conservative treatment, and self-care strategies as strictly active or passive, as it currently is not clear whether strategies commonly recommended by dental health-care providers (eg, application of heat and cold, splints, medications) are best viewed as passive coping or as active attempts to manage pain. Furthermore, despite the widespread use of the active versus passive coping distinction in the pain literature, comprehensive empirically-based categorizations of specific coping strategies have not been developed. Therefore, the first aim of this study was simply to describe the daily use of a variety of conservative treatment, self-care, and coping strategies.

The second aim was to examine associations between specific strategies and daily pain intensity within and between subjects. It was predicted that within-subjects, at times of greater pain, patients would report greater use of all types of coping, conservative treatment, and self-care strategies in an attempt to reduce their pain. It was further predicted that 2 strategies shown in cross-sectional studies to be associated positively with pain (activity reduction and expressing emotions/seeking emotional support) would also be associated positively with pain at the between-subjects level in

this daily diary study. It was hypothesized that relaxation would be associated negatively with pain at the between-subjects level (ie, patients who used more relaxation over the course of the study would report lower average pain levels), but positively at the within-subjects level (at times of increased pain, patients would be more likely to use relaxation to cope with the pain).

The third aim was to examine the associations of coping, conservative treatment, and self-care strategies with daily activity interference and jaw use limitations after controlling for pain intensity. It was hypothesized that between-subjects, after adjusting for pain intensity, use of relaxation would be associated negatively, and activity reduction and expressing emotions/seeking emotional support would be associated positively, with interference and jaw use limitations. It was further hypothesized that within-subjects, after controlling for concurrent pain intensity, greater use of activity reduction and emotional expression would be associated with greater interference and jaw use limitations. Other analyses were exploratory, because there was no theoretical or empirical rationale for hypotheses concerning other coping/treatment/self-care strategies.

Materials and Methods

Participants

Study participants were recruited from a dental school TMD/orofacial pain specialty clinic to participate in a randomized controlled trial (RCT) comparing a cognitive-behavioral pain management intervention to an education/attention control condition. Preliminary data from the RCT are reported elsewhere[22] and TMD treatment compliance data from a subset of the current sample were reported previously.[18] Inclusion criteria were age 18 to 70 years; residence within a 2-hour drive of the study site; ability to complete study measures; Research Diagnostic Criteria/Temporomandibular Disorders (RDC/TMD) Axis I TMD pain diagnosis[1] as determined by an oral medicine specialist based on a structured RDC/TMD clinical examination; pain duration of at least 3 months; and a Chronic Pain Grade[23] of II high, III, or IV, reflecting high pain and/or moderate to high pain-related disability. Exclusion criteria included the need for further diagnostic evaluation, pending litigation or disability compensation for pain, major medical or psychiatric illness that would interfere with ability to participate in the study, and current or prior

participation in cognitive-behavioral pain treatment. The study was approved by the University of Washington institutional review board, and all participants provided written informed consent.

Among 366 clinic patients who were approached and met the RCT eligibility criteria, 158 (43%) enrolled in the study, but 2 subjects were withdrawn from the study soon after enrollment due to psychiatric reasons. All subjects were asked to complete daily electronic diaries assessing their symptoms and behaviors during the 8-week study protocol, which included a 2-week baseline phase prior to the first study intervention session followed by 6 weeks of participation in 4 sessions of either pain management training or the education/attention control intervention. For the present report, only the electronic diary interviews completed prior to the first study intervention session were used; the RCT evaluation of the cognitive-behavioral treatment was not the subject of this report. Thirteen patients did not complete electronic diaries prior to the first session (3 due to handheld computer failure, 10 due to subjects' declining to complete the electronic interviews). Data from subjects who completed less than half of the interviews requested prior to the first study intervention session were also excluded (n = 6). This left a final sample of 137 patients for this report.

Among the 137 study participants, the mean (SD) age was 38 (11) years, and the majority (88%) were women. Most identified their racial/ethnic background as Caucasian (86%), but 4% were Asian/Pacific Islander, 2% American/Alaskan Native, and 8% in another category. Most (81%) had at least some college or vocational/technical training education. Forty-nine percent were married; 21% were divorced, separated, or widowed; and 30% had never married. Participants had experienced TMD pain a median of 5 years (interquartile range [IQR], 1 to 12 years), and the current pain episode a median of 14 months (IQR, 4 to 74 months). In t test and χ^2 comparisons of the 137 study participants with the 227 patients who declined to participate in the study or for whom electronic diary data were not available, no statistically significant difference was found on any variable for which study refuser information was available (age, gender, race, education, characteristic pain intensity,[23,24] pain-related disability,[24] and TMD clinical diagnosis).

Procedures

All participants completed a baseline questionnaire and then were trained in the completion of the

electronic diary interviews on handheld computers. In the training session, participants practiced completing electronic interviews and were asked to identify potential barriers to interview completion and to develop plans to overcome these. Participants were asked to page the study coordinator if they had any questions or problems using the computers at any time in the study. The study coordinator telephoned participants twice during the week after the training session to ask about interview completion and to assess and address problems completing interviews. Patients were paid $1 for each completed interview and received bonus payments at the end of the study based on percent of requested interviews completed. These bonus payments ranged from $15 to $32 for compliance rates between 95% and 100%.

Measures

Demographic and Clinical Characteristics. At the time of their initial TMD clinic visit, all patients are asked to complete a questionnaire that assesses information such as age, gender, race/ethnicity, education level, and facial pain duration.

Baseline Questionnaire Measures of Pain Coping. In order to assess the validity of coping scales derived from the electronic diary questions, the association between the standard questionnaire measures of pain coping completed at the baseline assessment and the electronic diary questions was analyzed. These included 4 subscales (Resting, Relaxation, Task Persistence, and Coping Self-Statements) of the Chronic Pain Coping Inventory (CPCI)[25] and the Coping Self-Statements scale of the Coping Strategies Questionnaire (CSQ).[26] Both pain coping questionnaires have been demonstrated to be reliable and valid.[7,25–27]

Electronic Diary Interviews

Each handheld computer was programmed to sound an alarm 3 times a day (morning, afternoon, and evening) at times determined by the participant, with the requirement that the chosen times be at least 3 hours apart and at least 3 hours after awakening in the morning to allow adequate sampling of the variables assessed across the course of the day. The alarm sounded every 5 minutes for 45 minutes until the patient began the interview or selected a radio button to postpone the interview for 5, 10, or 15 minutes. If the patient did not choose 1 of these options within 45 minutes, that interview was recorded as missed. Each interview was date- and time-stamped in the computer. The

electronic diary interview consisted of 35 questions. Most questions were adapted from previously validated measures of the construct of interest for use in a daily diary assessment format. For the current report, the following diary variables were analyzed:

Pain Intensity was assessed by a question from the Graded Chronic Pain Scale[23,24] (items on this scale can be adapted to specify type of pain and timeframe of interest): "In the past 3 hours, on average, how intense was your TMD pain (that is, your usual pain at times you experienced pain)?" Patients rated their pain on a scale from 0 (no pain) to 10 (pain as bad as could be).

Pain-Related Activity Interference was also assessed with an item from the Graded Chronic Pain Scale[23]: "In the past 3 hours, how much has TMD pain interfered with your activities?" Patients gave an answer on a scale from 0 (no interference) to 10 (unable to carry on any activities).

Jaw Use Limitation was assessed with the question, "In the past 3 hours, on average, how limited were you in ability to use your jaws?" Patients used a VAS scale from 0 (not at all linited) to 10 (severly limited) to respond to this question.

Pain-Coping Strategies were assessed using the following items from the Daily Coping Inventory,[28] modified[11] to assess a variety of daily pain-related coping attempts: Did something to try to reduce the pain (direct action); thought about solutions to the pain or gathered information about it; did something to help me relax; diverted attention from pain by thinking about other things or engaging in some activity (distraction); tried to see the pain in a different light that made it seem more bearable (redefinition); expressed emotions to reduce my anxiety, frustration, or tension about the pain; sought or found emotional support from loved ones, friends, or professionals; and sought or found spiritual support or comfort. Participants were also asked about their use of conservative treatment (wore splint, took medication for TMD) and self-care (applied heat, applied cold, passive jaw stretching, jaw relaxation) strategies commonly recommended by TMD clinicians, cognitive strategies (challenged my negative thoughts, told myself positive things) and behavioral strategies (did breathing exercises, did whole body relaxation exercise) often taught in cognitive-behavioral programs, and strategies often targeted for reduction in behavioral pain treatment programs (rested when the pain increased, decreased activity when the pain increased). For all 20 strategies, participants were asked to indicate whether they had used the strategy (yes-no) since the time of their last interview.

Some coping strategies were related conceptually. Using an expert consensus method,[29] the investigating team of 3 licensed clinical psychologists, a registered dental hygienist, and a dentist with extensive experience treating patients with TMD pain grouped related strategies into 4 categories based on content (face) validity: cognitive coping, activity reduction, relaxation, and seeking emotional support. Strategies that could not be grouped were analyzed individually. The item "did something to try to reduce the pain" was not categorized due to its general nature. However, this item was retained in the analyses to enable comparison of the results of the present study with those of other studies.[11,30] At the individual interview level, each multi-item scale was scored as a proportion (the number of strategies on that scale endorsed as used divided by the number of items on the scale), and individual items were scored as either endorsed or not.

Statistical Analysis

Diary Coping Scale Reliability and Validity. The authors wanted to ensure that the scales had adequate reliability and validity. An item judged to have face validity for a scale was dropped from the scale if its inclusion lowered the Cronbach's α coefficient[31] (internal consistency) of the scale substantially below 0.70[32] and if its correlation with the total scale score was low. For these reasons, "diverting attention" was dropped from the cognitive coping scale and "sought spiritual comfort" was dropped from the emotional support scale. Consistency of patient use of specific strategies over time ("stability") was measured by the intraclass correlation coefficient (ICC) within a subject based on the average use per day for each scale or item using all available observations across days 1 to 14. Pearson correlation coefficients were calculated between the average for days 1 to 7 and the average for days 8 to 14 to estimate scale and item stability from week to week. Pearson correlations were also used to examine discriminant validity (low correlations between measures of different constructs[29]) of the scales. To assess between-subject associations, the subject averages (mean scale scores) were used; to assess within-subject associations, the correlation among the subject deviations from the subject average was calculated. Significance testing of the within-subject associations was performed using the generalized estimating equation method because of the multiple observations per subject.[33] Criterion (concurrent) validity[34] of the diary coping scales was estimated

by the Pearson correlations between the diary scale (subject average) and baseline questionnaire measures of that construct. It was not possible to test the criterion validity of the seeking emotional support scale because of the lack of a comparable baseline questionnaire measure.

Association of Daily Coping, Conservative Treatment, and Self-Care Strategies with Concurrent Pain Intensity, Activity Interference, and Jaw Use Limitations. To describe average coping scale scores and individual strategy use per interview across all subjects, each subject's mean across all completed interviews was calculated. The median of the within-subject means was then calculated. Multilevel linear regression analyses were then used to examine the concurrent associations of each coping scale or individual strategy (and the total number of coping strategies, because this may be an important variable to examine in relation to pain-related outcomes[11]) with the diary pain, interference, and jaw use limitations measures. The unit of observation was the individual interview. Each regression model included both a between-subject (subject average) and within-subject (subject deviation from the subject average) coping variable and a random intercept term, and the within-subject associations were modeled as random effects. All analyses adjusted for time of day of interview (morning, afternoon, evening; treated as random effects) and subject sociodemographic characteristics (age, gender, and education). Analyses for activity interference and jaw use limitations were performed with and without controlling for concurrent pain intensity. In analyses that examined splint use, because not all patients were prescribed a splint, only those who reported using a splint at least once during the diary assessment period were included. A spatial power covariance structure was used for the residuals that allowed for auto-correlations that decay exponentially as a function of the time interval between interviews. To protect against misspecification of the covariance structure of the data, an empirical covariance estimator was used to estimate the standard errors and statistical significance of all fixed effects. To reduce the probability of a Type I error, Holm's procedure[35] was used to determine statistical significance for the tests conducted for the within- and between-subjects associations. The Holm's procedure does not produce an adjusted *P* value but rather suggests whether the association is still statistically significant at a .05 level after adjusting for the multiple comparisons. Finally, following the approach of Todd et al,[36] multilevel linear regression analyses were con-

Table 1	Daily Diary Coping Scales: Items and Internal Consistency
Scale/item	Cronbach's α
Cognitive coping scale	0.78
Tried to see the pain in a different light that made it seem more bearable (redefinition)*	
Thought about solutions to the pain or gathered information about it*	
Challenged my negative thoughts	
Told myself positive things	
Activity reduction scale	0.88
Rested	
Decreased activity	
Relaxation scale	0.64
Did something to help me relax*	
Relaxed face/jaw muscles	
Did breathing exercise	
Did whole-body relaxation exercise	
Emotional support scale	0.79
Expressed emotions to reduce my anxiety, frustration, or tension about the pain*	
Sought or found emotional support from loved ones, friends, or professionals*	

*From the Daily Coping Inventory.[28]

Table 2	Stability Estimates for Coping Scales, Individual Strategies, and Total Number of Strategies Used	
Scale/Item	Daily stability (r)*	Weekly stability (r)†
Coping scales		
Cognitive coping	0.77	0.87
Activity reduction	0.59	0.82
Relaxation	0.68	0.83
Emotional support	0.64	0.79
Individual coping items		
Did something to try to reduce pain (direct action)	0.59	0.82
Diverted attention (distraction)	0.60	0.80
Spiritual comfort	0.75	0.91
Wore splint	0.66	0.87
Applied heat	0.62	0.80
Applied cold	0.58	0.77
Jaw stretches	0.62	0.79
Medication for TMD	0.66	0.85
Total number of coping strategies‡	0.78	0.87

*Intraclass (pairwise) correlation coefficients based on average use per day for each coping strategy and correlated across days 1 to 14; all P values < .001.
†Pearson's correlation between days 1 to 7 average and days 8 to 14 average; all P values < .001.
‡Excluding splint use (ie, based on 19 individual strategies).

ducted to estimate simultaneously the between-person variance and the within-person variance of the outcome measures explained by all the strategies as a group after adjusting for sociodemographic characteristics and time of day of interview (and pain intensity in models for interference and jaw use limitations). All regression analyses were performed using SAS PROC MIXED, SAS software version 9.1.

Results

Electronic Interview Compliance and Descriptive Information

The study protocol called for a 2-week baseline prior to the first study intervention session, but due to scheduling constraints, some participants provided fewer or more than 2 weeks of data prior to the first session (median, 14 days; range, 6 to 33 days). The mean (SD) percent of requested interviews completed prior to the first session was 90% (11%) and the mean (SD) number of completed interviews was 40 (12). The mean pain intensity rating (SD) (mean of within-subject means) across subjects was 4.3 (2.0) and pain was reported in 93% (mean across subjects; SD = 2%) of the inter-

views. The mean (SD) pain-related activity interference rating was 2.9 (2.2) and interference was reported in a mean of 74% (3%) of the interviews. The mean (SD) jaw use limitations rating was 3.3 (2.4), with limitations in jaw functioning reported in a mean of 82% (3%) of interviews.

Coping Scale Reliability and Validity

The diary coping scales (cognitive coping, activity reduction, relaxation, and emotional support) had acceptable to excellent internal consistency (Cronbach's α range, 0.64 to 0.88; Table 1) and the daily coping items and scales showed relatively high stability across the 2 weeks (Table 2). The use of particular coping strategies was more stable from week to week (weekly stability: r = 0.72 to 0.91 across the 20 strategies) than from day to day (daily stability: r = 0.49 to 0.79 across the 20 strategies).

The within- and between-subject Pearson r correlations between pairs of coping scales were: cognitive coping and activity reduction, 0.17, 0.39; cognitive coping and relaxation, 0.33, 0.59; cognitive coping and emotional support, 0.26, 0.68; relaxation and emotional support, 0.20, 0.58; relaxation and activity reduction, 0.35, 0.54; activity reduction and emotional support, 0.12, 0.53 (P < .001 for all). The generally low correlations within-sub-

jects suggest that the coping scales assess different coping strategies used within individuals over time. The generally moderate and positive between-subjects associations may reflect, in part, a shared method variance of the diary measures.

Criterion validity of the diary scales was supported by statistically significant correlations with the baseline coping questionnaire measures in the expected directions: diary cognitive coping and CPCI Coping Self-Statements ($r = 0.39$, $P < .001$), diary relaxation and CPCI Relaxation ($r = 0.49$, $P < .001$), diary activity reduction and CPCI Rest ($r = 0.53$, $P < .001$), and diary activity reduction and CPCI Task Persistence ($r = −0.39$, $P < .001$). However, the diary cognitive coping scale was not correlated significantly with the CSQ Coping Self-Statements scale ($r = 0.14$, $P = .11$).

Daily Use of Pain Coping, Conservative Treatment, and Self-Care Strategies

Figure 1 displays information about scores on the 4 coping scales (scored as proportions of items endorsed) and use of the 8 individual strategies not on the coping scales. The relaxation and activity reduction scales showed higher average scores per interview (median of the within-subject means = 0.39 for each scale; relaxation IQR, 0.28 to 0.52; activity reduction IQR, 0.16 to 0.65) than did the cognitive coping (median [IQR], 0.15 [0.05 to 0.42]) and seeking emotional support (median [IQR] = 0.15 [0.03 to 0.29]) scales. Some notable differences emerged in the relative use of individual items within 2 of the coping scales. Within the cognitive coping scale, "told myself positive things" was endorsed much more frequently (median [IQR] of within-subject means, 29% [5% to 76%] of interviews) as compared with the other items (median range, 3% to 8%). In the relaxation scale, "did something to help me relax" (median [IQR] = 67% [41% to 82%]) and "relaxed face/jaw muscles" (median [IQR] = 81% [44% to 96%]) were reported with a much greater frequency than were either "did breathing exercise" (median [IQR] = 8% [0% to 27%]) or "did whole body relaxation exercise" (median [IQR] = 5% [0 – 21%]). The reported use of individual items within the activity reduction and emotional support scales was distributed approximately evenly.

Among the 20 individual strategies, 6.4 strategies were reported on average (median of within-subject means) in each interview (IQR, 4.0 to 8.7). Among the individual strategies not included in the 4 scales, "did something to try to reduce pain" (direct action) was the item endorsed most frequently
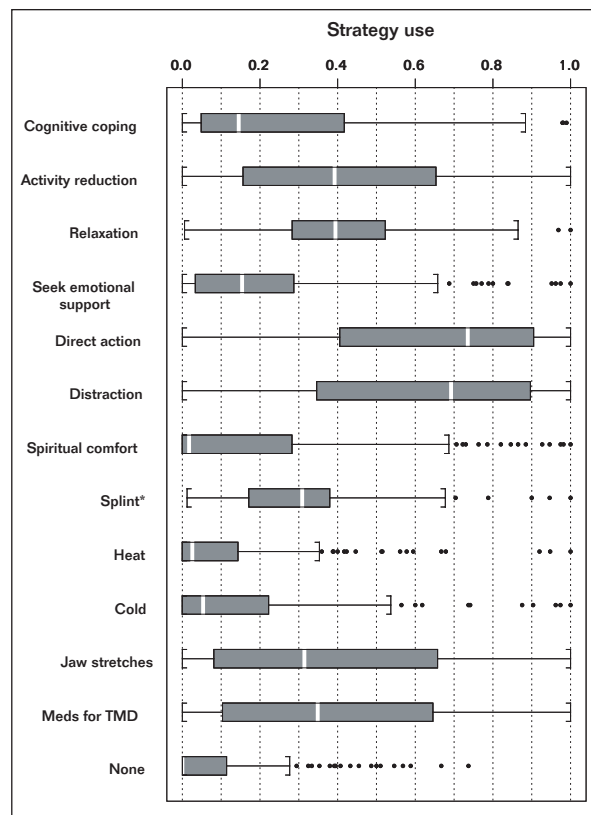

Fig 1 Use of pain coping, self-care, and treatment strategies. The boxplot displays the distribution of the within-subject means. Medians are represented by the vertical white line in each box. The left and right edges of the box show the 25th and 75th percentiles, respectively. The nearest values not beyond 1.5 times the IQR are demonstrated by the whiskers, and the solid dots (·) indicate outliers. The first 4 strategies were assessed by multi-item scales scored as a proportion of items endorsed; the others are single-item strategies scored as yes-no at the individual interview level. *Includes only subjects who reported that they wore a splint at least once (n = 79) during the diary assessment period.

(median [IQR] of the within-subject means 74% [41% to 90%] of interviews), followed closely by "diverted attention" (distraction) (median [IQR] = 69% [35% to 90%]). "Medications for TMD" (median [IQR], 35% [10% to 65%]) and "jaw stretches" (median [IQR], 31% [8% to 66%]) were reported in about a third of interviews, while "sought/found spiritual comfort," "applied cold," and "applied heat" were the least frequently endorsed items (≤ 5%). Among the 79 subjects who used a splint at least once, splint use was reported in a median of 67% of morning interviews (reflecting use during the night), 8% of afternoon interviews, and 7% of evening interviews.

Table 3 Concurrent Associations of Strategies with Pain Intensity, Controlling for Time of Day of Interview, Age, Gender, and Education

	B	SE	P
Between-subject associations			
Cognitive coping scale	1.1	0.7	.095
Activity reduction scale	2.8	0.5	<.001*
Relaxation scale	2.0	0.7	.004*
Emotional support scale	2.9	0.7	<.001*
Did something to reduce pain (direct action)	2.8	0.5	<.001*
Diverted attention (distraction)	1.4	0.5	.006*
Spiritual comfort	1.2	0.6	.03
Wore splint†	0.5	0.9	.55
Applied heat	2.6	0.8	<.001*
Applied cold	3.4	0.6	<.001*
Jaw stretches	1.3	0.5	<.01*
Medication for TMD	2.4	0.5	<.001*
Within-subject associations			
Cognitive coping scale	0.7	0.2	.001*
Activity reduction scale	0.5	0.1	<.001*
Relaxation scale	0.3	0.1	.001*
Emotional support scale	0.6	0.1	<.001*
Did something to reduce pain (direct action)	0.7	0.1	<.001*
Diverted attention (distraction)	0.3	0.1	.004*
Spiritual comfort	0.2	0.1	.05
Wore splint†	0.2	0.1	.049
Applied heat	0.6	0.1	<.001*
Applied cold	0.4	0.1	<.001*
Jaw stretches	0.3	0.1	.002*
Medication for TMD	0.6	0.1	<.001*

*Indicates statistical significance after adjusting for multiple comparisons with the Holm's correction procedure.
†Includes only subjects who reported splint use at least once during the period of observation (n = 79).

Associations of Daily Coping, Conservative Treatment, and Self-Care Strategy Use with Concurrent Pain Intensity, Activity Interference, and Jaw Use Limitations

Pain Intensity. Pain level was significantly higher in the evening as compared to the morning (P = .015). There were no significant associations between sociodemographic characteristics (age, gender, education) and pain intensity. Controlling for these covariates, the total number of strategies reported was associated significantly and positively with pain intensity both between- and within-subjects (B [SE] = 0.21 [0.04], P < .001; B [SE] = 0.10 [0.01], P < .001, respectively, with B as an unstandardized regression coefficient). With the exception of splint use, the cognitive coping scale, and seeking spiritual comfort, all scales and strategies not on scales were significantly and positively associated with pain intensity at the between-subjects level (Table 3).

Similarly, within-subjects analyses showed that at times of greater pain, the patients were more likely to use nearly all types of strategies. However, the associations for splint use and seeking spiritual comfort were not statistically significant, suggesting that their use was less dependent on fluctuating pain levels. As a group, the coping, treatment, and self-care strategies explained 26% of the between-subject variance and 21% of the within-subject variance in daily TMD pain.

Activity Interference. As in the case of pain intensity, activity interference was higher in the evening as compared to the morning (P < .001). No sociodemographic characteristic was associated significantly with activity interference. Controlling for sociodemographic characteristics, time of day, and pain, the total number of strategies used was associated positively with activity interference at the within-subject level (B [SE] = 0.03 [0.01], P < .001), but not between-subjects (B [SE] = 0.01 [0.03], P = .61).

Table 4   Daily Pain Coping, Treatment, and Self-Care Strategies: Concurrent Relationships with Activity Interference, Unadjusted and Adjusted for Pain Intensity

	Activity interference unadjusted			Activity interference adjusted		
	B	SE	*P*	B	SE	*P*
Between-subject associations						
Cognitive coping scale	1.2	0.7	.10	0.2	0.4	.65
Activity reduction scale	3.2	.5	<.001*	0.8	0.3	.02
Relaxation scale	1.6	0.7	.03	–0.2	0.4	.59
Emotional support scale	3.2	0.8	<.001*	0.6	0.5	.60
Did something to reduce pain (direct action)	2.5	0.5	<.001*	0.1	0.3	.85
Diverted attention (distraction)	1.3	0.6	.03	0.0	0.3	.94
Spiritual comfort	1.8	0.6	.004*	0.8	0.3	.02
Wore splint[†]	0.4	0.9	.66	–0.1	0.5	.92
Applied heat	2.1	0.9	.23	–0.3	0.6	.66
Applied cold	2.5	0.8	.002*	–0.6	0.7	.38
Jaw stretches	0.9	0.5	.09	–0.3	0.3	.38
Medication for TMD	2.2	0.6	<.001*	0.1	0.4	.84
Within-subject associations						
Cognitive coping scale	0.5	0.2	.003*	0.1	0.1	.30
Activity reduction scale	0.7	0.1	<.001*	0.4	0.1	<.001*
Relaxation scale	0.1	0.1	.21	–0.1	0.1	0.14
Emotional support scale	0.6	0.1	<.001*	0.2	0.1	.001*
Did something to reduce pain (direct action)	0.5	0.1	<.001*	0.1	0.0	.045
Diverted attention (distraction)	0.1	0.1	.26	–0.1	0.1	.19
Spiritual comfort	0.2	0.1	.056	0.1	0.1	.17
Wore splint[†]	0.1	0.1	.56	–0.04	0.1	.51
Applied heat	0.5	0.1	<.001*	0.2	0.1	.05
Applied cold	0.4	0.1	<.001*	0.2	0.1	.02
Jaw stretches	0.3	0.1	<.001*	0.1	0.1	.009
Medication for TMD	0.4	0.1	<.001*	0.1	0.1	.04

Between- and within-subject effects (unstandardized maximum likelihood estimates), controlling for time of day of interview and sociodemographic variables (age, gender, education) (unadjusted) and time of day of interview, sociodemographic variables, and concurrent pain intensity (adjusted).
*Indicates statistical significance after adjusting for multiple comparisons with the Holm's procedure.
[†]Includes only subjects who reported splint use at least once during the period of observation (n = 79).

Table 4 shows the concurrent associations of the individual strategies with activity interference. The models unadjusted for pain intensity indicate that in general, more frequent use of strategies was related to greater activity interference at the between-subjects level, and within-subjects, patients were more likely to use most strategies at times of higher activity interference. Because these associations could reflect greater coping efforts when pain is greater (given the association between pain and interference), the analyses were repeated controlling for pain intensity. As expected, pain intensity (controlling for time of day and sociodemographic characteristics) was strongly associated with activity interference both between-subjects (B [SE] = 0.89 [0.05], P < .001) and within-subjects (B [SE] = 0.56 [0.02], P < .001). Pain intensity explained 68% of the between-subject variance and 39% of the within-subject variance in interference, leaving relatively

little variance (particularly at the between-subjects level) that could be explained by other factors, including coping, treatment, or self-care strategies. At the between-subjects level, no strategy was associated significantly with activity interference after adjusting for pain intensity and multiple comparisons. At the within-subjects level, only 2 of the coping strategies (activity reduction and emotional support) and none of the self-care/treatment strategies remained statistically significant after controlling for pain level and correcting for multiple comparisons. The amount of between-subject and within-subject variance in activity interference explained by the strategies as a group was 5.7% and 3.3%, respectively.

Jaw Use Limitations. The results for jaw limitations mirrored those for activity interference in that although many strategies showed positive and statistically significant associations, no between-subjects and only 1 within-subject (activity reduc-

tion) association remained significant after adjustment for pain intensity and correction for multiple comparisons. Emotional support and application of cold showed trends toward significance ($P = .02$ and .007, respectively; not statistically significant after correction for multiple comparisons). As a group, the strategies explained 0% of the between-subject variance and 6.1% of the within-subject variance in jaw use limitations after controlling for sociodemographic characteristics, time of day, and pain intensity.

Discussion

The importance of patient coping and self-management for chronic health conditions, including chronic pain, has been increasingly recognized.[37,38] Appropriate and consistent use of coping, treatment, and self-care strategies to self-manage chronic health conditions has the potential to result in more efficient use of health care resources, increased patient sense of control, greater patient satisfaction with care, and improved outcomes.[37] Use of such strategies may be particularly important in conditions (such as chronic TMD pain) for which definitive curative treatments are not available. The authors recently demonstrated that TMD patients' self-efficacy for managing pain is an important factor in how they cope with their pain.[39] One of the primary goals of this study was to describe the daily use of a wide array of such strategies among TMD clinic patients with high levels of pain and/or pain-related disability. The finding that TMD clinic patients concurrently use multiple pain coping strategies in conjunction with dentist-recommended conservative treatment and self-care strategies is consistent with findings in other populations that people with chronic pain use a wide range of self-management strategies.[38] In both research and clinical arenas, it is possible that focus on a single strategy in isolation may result in failure to understand how the combinations of individual coping, treatment, and self-care strategies actually used by patients affect their outcomes; research is needed to determine the extent to which individual strategies versus combinations of strategies are associated with patient outcomes.

Daily real-time interviews and multilevel statistical analyses allowed the examination of associations between the use of particular strategies and variations in daily pain intensity at both between-subjects and within-subjects levels. Within-subjects analyses revealed that at times of increased pain,

the patients were significantly more likely to use all types of strategies examined except seeking spiritual comfort and wearing a splint. The between-subjects analyses indicated that patients who had higher levels of pain over the course of the study also reported greater use of all strategies except wearing a splint, cognitive coping, and seeking spiritual comfort. Most patients reported little or no use of seeking spiritual comfort, although a few used this strategy frequently. The lack of association of splint use with pain likely reflects the typical practice in the authors' TMD/orofacial pain clinic of instructing patients who are prescribed splints to wear them at night regardless of pain level.

The hypothesis that use of relaxation would be negatively associated with pain between-subjects, but positively within-subjects, was only partially confirmed: A positive and statistically significant association was found both within- and between-subjects. The hypothesis that relaxation would be associated negatively with interference and jaw use limitations at the between-subjects level after controlling for pain was not confirmed: The associations were not statistically significant. Use of relaxation has been associated with lower pain and distress in some studies,[11,40] but not in others.[7,8,25,41] Although TMD dental specialists in the authors' clinic typically advise TMD patients to relax their jaw muscles, the patients in the present study had not received specific training in methods such as progressive muscle relaxation and abdominal or diaphragmatic breathing. These techniques are often taught in cognitive-behavioral treatment (CBT) programs for chronic pain[42] and may be found beneficial by patients with TMD pain. It would be of interest to examine the association between use of such techniques and interference/disability among patients who had received such training.

As hypothesized, activity reduction (resting and decreasing activity) was associated positively with pain intensity at both the between-subjects and within-subjects level. After adjusting for multiple comparisons and for pain intensity, the associations of activity reduction with activity interference and jaw use limitations were not statistically significant at the between-subjects level. However, as hypothesized, greater use of activity reduction was associated within-subjects with significantly greater interference and jaw use limitations. This finding adds further support to the existing evidence that resting and decreasing activity in response to pain are associated with worse patient outcomes.[10,14,43] However, it is important to note that in the present study, the conceptual overlap between the activity

reduction coping items and the outcome measures of activity interference and jaw use limitations may have contributed to their associations.

As hypothesized, expressing emotions/seeking emotional support was associated positively with pain at both the between- and within-subjects levels. It was also hypothesized that this coping strategy would be associated positively between- and within-subjects with interference and jaw use limitations, even after controlling for pain intensity. The results supported this hypothesis at the within-subjects level, but not at the between-subjects level. In other words, regardless of pain level, individuals tended to be more likely to express emotions and seek emotional support at times when pain interfered more with their activities. This finding is consistent with observations from previous studies of patients with TMD and arthritis that emotional expression is associated with worse outcomes.[13,37]

The use of electronic diary methodology to assess coping-strategy use represents a novel approach in research involving patients with TMD. The current results provide preliminary support for the reliability and validity of the 4 diary coping scales, suggesting their suitability for use in future daily diary studies of patients with TMD pain. However, additional research is needed to assess the psychometric properties of these scales in additional patient samples. A "yes-no" format was used so that the coping items would be consistent with the format used in previous studies,[11,30] but this makes it difficult to assess amount of coping. Research is needed to test different response formats that might best capture the extent to which a particular type of coping strategy was used. Furthermore, the electronic diary method used (handheld computer interviews 3 times daily over a period of weeks) is not practical in "real-world" clinical settings. However, the present study and others demonstrate that such research methods can be used successfully to identify variables that warrant examination in subsequent research with potentially important implications for the treatment of patients with TMD.

For example, the results of the present study suggest directions for future research that may have direct clinical relevance. The significant associations found suggest strategies to examine in future research, using time periods longer than the 2 weeks of the current study and using different lags (eg, using coping-strategy use over a period of weeks or months to predict subsequent changes in pain and activity interference). Both observational and experimental studies are needed. For example,

further research is needed to determine whether, when level of pain is controlled for, TMD patients who respond to increased pain by resting and avoiding activity and/or expressing emotions and seeking emotional support show greater role limitations and functional disability over time as compared with patients who persist in activities or who work to self-regulate negative emotions despite pain flare-ups. Research is also needed to assess the efficacy of interventions targeted at changing the pain-coping responses of TMD patients who respond to pain increases by resting and reducing activity or by seeking support from others. Such patients might be taught to persist in activities despite pain increases and to use self-regulation techniques (eg, stress management techniques, identify and challenge negative thoughts) to manage stress and negative emotions that can arise at times of an increase in pain level.

The authors did not create a scale encompassing commonly prescribed conservative treatment and self-care strategies for TMD such as use of a splint, application of heat or cold to the painful area, passive jaw stretches, and medication use because of the theoretical and practical independence of such therapies. Dental clinicians may prescribe only 1, or any combination, of these strategies for an individual patient, and some of these strategies may be contraindicated for a particular patient. For example, jaw stretches and splints may be contraindicated for patients with disc displacement, but such patients may be encouraged to apply cold packs. As a result, it is recommended that future studies in this area examine use of conservative treatment and self-care strategies individually.

The pain coping, conservative treatment, and self-care strategy measures showed a high degree of stability from day to day and an even higher degree of stability from week to week. Thus, this group of TMD clinic patients tended to be consistent over a 2-week period in their use of such strategies. Although one would expect that the patients would have shown some consistency in their use of strategies given that they had experienced TMD pain a median of 5 years, to the authors' knowledge, these data represent the first documentation of a high level of consistency in use of pain-coping, treatment, and self-care strategies by patients with chronic TMD pain.

Several limitations of our study deserve mention. First, similar to other diary-based studies, information was obtained via patient self-report and was not corroborated by data on coping efforts and functioning from other sources. However, dentists and study investigators did not have access to

patient diary responses during the study, so we do not think it likely that subjects' diary responses were influenced by desires to please their dentist or study investigators. Second, the study enrollment rate was low, and although no differences between study participants and refusers were noted on any sociodemographic or clinical variable examined, further research is needed to determine the generalizability of the study findings to other populations of individuals with chronic TMD pain. In particular, the use of coping and self-care strategies in the present sample of patients with high levels of pain and/or activity interference recruited from a particular TMD clinic might differ from those of individuals with TMD pain who have lower pain and disability levels and/or are not patients in a TMD clinic oriented toward conservative treatments.

In summary, TMD clinic patients who experience high pain or dysfunction report using a wide variety of coping, conservative treatment, and self-care treatment strategies, some of which are significantly related to concurrent pain, activity interference, and jaw use limitations. The coping, treatment, and self-care diary measures used in this study may prove fruitful in continued efforts to promote self-management for this common chronic pain condition. For example, the measures could be used in studies that examine the long-term effects of use of specific strategies in terms of impact on pain, activity interference, and psychological distress, and thereby identify strategies to target in interventions. These measures could also be used in experimental studies to determine whether treatments designed to increase patient use of presumably beneficial coping, treatment, and self-care strategies, and to decrease patient use of strategies believed to be maladaptive, result in the desired changes, and whether these changes are associated with improved clinical outcomes.

Acknowledgments

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