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TMD DIAGNOSTIC GROUPS AFFECT OUTCOMES INDEPENDENTLY OF TREATMENT IN PATIENTS AT-RISK FOR DEVELOPING CHRONICITY: A TWO-YEAR FOLLOW-UP STUDY+

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Abstract

Aims—To assess whether a biobehavioral intervention would be more effective for patients with myogenous temporomandibular disorder (m-TMD) when compared to other patients receiving either a self-care intervention or no intervention. Three outcomes were assessed: psychosocial distress; pain; and functioning.

Methods—Participants (n=435) were from community dental clinics in the Dallas-Fort Worth Metroplex seeking treatment for their acute TMD symptoms, and were recruited between 2008 and 2013. Outcome evaluations were conducted immediately post-intervention, as well as at 1- and 2-years after the interventions. For the current study, analyses using two-level hierarchical Multilevel Linear Models (MLMs) were conducted.

Results—Contrary to expectations, patients did not respond differently to the intervention based on their TMD diagnosis. However, acute m-TMD patients, especially those who had other comorbid TMD diagnoses, reported the highest levels of pain and pain-related symptoms and disability. They also exhibited poorer jaw functioning, especially if they were at high-risk for chronic TMD.

Conclusion—This study supports the finding that acute m-TMD tends to result in more severe symptom presentations, particularly if diagnosed in combination with other TMD diagnoses. Additionally, patients do not appear to respond better to biobehavioral treatment or self-care on the basis of their diagnoses.

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Keywords

temporomandibular disorder, acute myogenous pain, RDC/TMD, psychosocial distress, high-risk

INTRODUCTION

Both the temporomandibular joint and the associated muscular structures enable horizontal and vertical movements through sliding and bending motions but, when a dysfunction or abnormality arises in any of these areas, a condition called Temporomandibular Disorder (TMD) develops, which is a common musculoskeletal condition affecting the orofacial region.^{1–5} According to the National Institute of Dental and Craniofacial Research (NIDCR), about 10 million people in the USA (i.e., 4% of the population) are suspected to have TMD.^{4, 6} Relatedly, it is estimated that TMD patients spend over \$4 billion per year to treat their symptoms.^{6, 7} These high costs are related to the multifaceted symptom presentation of the disorder. TMD impairs jaw functioning and can promote complications such as stiffening in the jaw, orofacial pain, a restricted range of motion in the mandibular joints, and abnormal or audible jaw movements (e.g., clicking and popping).^{4, 8–13} Overall, pain is documented as the most common symptom of TMD, and it typically dictates treatment-seeking behavior.^{1, 4, 11, 14–20} In order to better address this prevalent and costly condition, treatments have become more focused on conservative, reversible approaches instead of more invasive procedures. Indeed, the Institute of Medicine Report, “Relieving Pain in America,” emphasized the need to develop cost-effective, early interventions to better manage pain and prevent chronicity. To begin this process, in a recent publication,²¹ various studies were reviewed that focused on acute TMD patients who were at-risk for developing chronic and costly TMD problems.^{7, 13, 22–31} Overall, findings revealed that an early biobehavioral intervention for at-risk acute TMD patients was efficacious in preventing chronicity. Because of space limitations, the reader is referred to the aforementioned citations for a comprehensive review of these studies. The present study extends the findings reported by Dougall and colleagues²¹ by performing subgroup analyses of the main TMD intervention group findings.

At the outset, it should also be noted that the Research Diagnostic Criteria for Temporomandibular Disorder (RDC/TMD) diagnostic system³² has garnered much acceptance and international use in objectively diagnosing and assessing TMD for clinical research purposes.^{25, 33, 34} According to some clinical researchers, TMD is actually considered to be a set of disorders as opposed to being only one condition.¹⁷ This perspective is supported by the various sub-diagnoses that one can be given.²⁰ The physical symptoms are used to assign diagnoses: myofascial TMD (m-TMD); disc displacements; and degenerative joint diseases. Within each diagnosis, there are also sub-groups. Furthermore, it has been found that m-TMD, particularly myofascial pain, was the most prevalent diagnosis.^{12, 16, 35–39} In addition, past research has shown that psychosocial distress (e.g., depressive symptoms, stress, somatization, etc.) shares a strong relationship with m-TMD diagnoses.^{2, 39–41} Indeed, in a recent review of the literature, Velly and colleagues⁴² highlighted the various psychosocial comorbidities (e.g., stress, anxiety, depression, catastrophizing, etc.) that are common among patients with orofacial pain,

especially TMD-related pain. According to the RDC/TMD, in order to be diagnosed with m-TMD, one must endorse pain upon palpation in at least three locations of the extraoral muscles and/or the intraoral muscles;³⁰ therefore, the experience of pain is inherent in a diagnosis of m-TMD. All TMD diagnostic groups (i.e., RDC/TMD Axis I) have been linked to poor health outcomes.⁴³ Dahan and colleagues⁴⁴ have also recently reported that patients with m-TMD had a greater prevalence of self-reported migraine and chronic fatigue syndrome, relative to those with non-myofascial TMD.

Historically, TMD has been known as a chronic pain condition and, because over one-third of all costs associated with such a condition are attributed to orofacial pain, some members of the present research team engaged in an investigation to determine how chronic TMD individuals differed from non-chronic TMD individuals.²⁷ This led to further research which helped develop an algorithm differentiating between those at either a high-risk or a low-risk of developing chronic TMD.³⁶ Most recently, it was reported that biobehavioral and self-care interventions can be effectively implemented in a community setting to improve symptoms of pain, functionality, and psychosocial symptoms among patients at high-risk for chronic TMD.²¹ Moreover, the biobehavioral intervention produced a quicker response and the self-care intervention was more likely to lose effectiveness over time.

Based upon the above array of findings, the purpose of the current study was to assess whether the effectiveness of a biobehavioral intervention for acute TMD patients would vary by diagnosis in terms of reducing psychosocial distress, reducing pain, and improving functionality, relative to patients receiving either a self-care intervention or no intervention. Particularly, it was expected that m-TMD patients would exhibit worse symptoms at the outset of the study, and report greater improvements following treatment. Interestingly, pain that is evoked from the jaw joints does not appear to be as debilitating as myogenous pain,⁴³ and this may be because m-TMD, in particular, is inherently painful and affects a larger portion of the craniomandibular region as compared to other TMD diagnoses (i.e., disc displacements and joint diseases).⁴⁵ This discomfort can spread into other aspects of a TMD sufferer's life and, therefore, it was believed that myogenous diagnoses would result in a heightened experience of various TMD-related symptoms.

It should also be noted that oral parafunctional habits (e.g., clenching, grinding, etc.) are highly related to m-TMD diagnoses.^{2, 40, 46} Investigating these symptoms will help determine whether there are differential treatment effects in an acute TMD population according to RDC/TMD diagnoses. Moreover, because muscle disorders are common among TMD sufferers,^{13, 16, 35–39} it is clinically important to determine if the subset of patients with a myogenous diagnosis benefit more from an early biobehavioral intervention relative to other patients with a different diagnosis. Specifically-tailored treatment protocols might then be shown to be more effective for certain patients, in keeping with the current call for “precision medicine” (e.g.,⁴⁷). Again, investigations of acute TMD populations are imperative given the pervasiveness,^{4, 6} high costs,^{6–8, 24} and debilitating nature of the disorder upon becoming chronic.^{1, 9, 48–50} Such factors can also be magnified when considering the number of co-occurring TMD diagnoses. Unfortunately, some studies have excluded patients with multiple TMD diagnoses,^{2, 51} despite the fact that they are relatively common.^{29, 30, 36, 37, 39, 52, 53} This present study, however, included analyses of patients with

multiple diagnoses and, thus, is more generalizable and will significantly add to the TMD literature.

On the basis of the above, the goal of the present study was to evaluate whether a biobehavioral intervention would be more effective for acute m-TMD patients in terms of reducing psychosocial distress, reducing pain, and improving functioning, when compared to other patients with acute m-TMD receiving either a self-care intervention or no intervention. Additionally, it was hypothesized that patients with m-TMD would present with worse symptoms (psychosocial distress, pain, functioning) than patients with other TMD diagnoses, but that they would respond more favorably to the biobehavioral intervention.

METHODS

Overall, patients with acute TMD were administered the RDC/TMD, as well as the earlier-referenced algorithm for determination of their risk status, either “high-risk” (HR) or “low-risk” (LR), for developing chronicity.²⁶ This proprietary algorithm consisted of combining two components of the RDC/TMD: self-reported characteristic pain intensity scores; and certain diagnostic indices of myofascial pain. The HR patients were then randomly assigned to an early biobehavioral intervention (HR/BB) or an early self-care intervention (HR/SC). The LR patients were not assigned to either intervention (LR/NI), but were not refrained from seeking any treatment on their own.

Participants

To be eligible for the current study, the participants were required to meet certain inclusion/exclusion criteria, which were as follows: (1) be 18 years old or older; (2) have experienced jaw pain no more than six months prior to entering the study; (3) have no history of chronic jaw or face pain; and (4) have no comorbid, pain-exacerbating condition³³ (e.g., fibromyalgia, low back pain, etc.).³ Participants were recruited in community dental clinics in the Dallas-Fort Worth Metroplex for their TMD symptoms, between 2008 and 2013, in the following ways: referrals from community dental clinics; flyers which described the study; word-of-mouth; internet advertisements; and advertisements disseminated to a mailing list of potential participants. All participants signed an informed consent form. This consent form, as well as the study itself, was approved by the Institutional Review Boards of the University of Texas at Arlington and Texas A&M University Baylor College of Dentistry.

As can be seen in Table 1, the overall sample was middle-aged, and consisted mainly of individuals who were college-educated, Caucasians, females, married, and who had a combined household income of at least \$50,000. In addition, there were no demographic differences among the three intervention groups. It should also be noted that the majority of patients had an Axis I RDC/TMD diagnosis: m-TMD only ($n = 95$); disc displacement only ($n = 20$); degenerative joint disease only ($n = 43$), multiple diagnoses including m-TMD ($n = 187$); multiple diagnoses excluding m-TMD ($n = 10$); and no diagnosis ($n = 80$).

Measures

As previously delineated by Dougall and co-workers,²⁹ trained clinicians administered the RDC/TMD, including the components of the “at-risk” screening algorithm.²⁶ The RDC/TMD is comprised of two axes. Axis I involves a physical evaluation which yields the different TMD categories (described earlier). Axis II consists of self-report measures assessing psychosocial factors commonly seen in TMD patients. The RDC/TMD evaluators were initially trained on the RDC/TMD administration by an experienced oral surgeon. Inter-rater reliability for correct completion of the TMD exam was initially conducted on non-subject volunteers prior to the start of the study. Quality control of evaluations was maintained by re-evaluating randomly selected cases throughout the project (all cases were recorded), as well as re-calibrating evaluators when needed. The initial guidelines delineated developed by Dworkin, LeResche and Derouen⁵⁴ were followed. This produced close to 100% reliability among evaluators because of routine re-calibration sessions (as was done in our previous TMD studies). However, in such large-scale investigations such as the present, there were sometimes inadvertent errors made in entering some values correctly in the administration forms during the assessment process. These errors, though, were minimal.

CPI—The Characteristic Pain Inventory (CPI) consists of 3 items, which ask participants to rate the severity of the pain they have been experiencing, from 0 (“no pain”) to 10 (“pain as bad as could be”), in reference to 3 items: (1) current pain; (2) worst pain during the previous 6 months; and (3) average pain during the previous 6 months. The responses to these 3 items were averaged, and then multiplied by 10 to get a pain rating from 0 to 100, with higher numbers corresponding to more pain. In the present sample, the CPI showed high reliability, $\alpha = .88$.

GCPS—The Graded Chronic Pain Scale (GCPS) is a validated scale that uses a combination of two different measures: the CPI and pain-related disability items.^{40, 55, 56} In addition to the 3 CPI items used for the GCPS, there are 4 pain-related disability items, of which 3 assess the degree to which pain has interfered with daily activities from 0 (“no interference”) to 10 (“unable to carry on any activities”). The fourth pain-related disability item asks participants to indicate the number of days they have not been able to perform their usual activities. The responses to all seven items were then used to determine five grades of disability, from zero (“no disability”) to four (“high disability-severely limiting”).

Somatization—Both of the somatization measures are derivatives of the Symptom Checklist-90. The painful somatization scale consists of 12 items that gauge painful somatization tendencies (e.g., headaches, nausea, muscle soreness, etc.), and which are measured on a 5-point scale from 0 (“not at all”) to 4 (“extremely”). The responses to the items were averaged to provide an overall score. In the present sample, the painful somatization scale showed high reliability ($\alpha = .85$). The non-painful somatization scale consists of seven items that gauge non-painful somatization tendencies (e.g., numbness, dizziness, feeling weak, etc.) that are assessed on the same five-point scale as the painful somatization measure, and the responses to the items were averaged to provide an overall score. Higher scores on each somatization scale indicated an endorsement of somatization

tendencies and, in the present sample, the non-painful somatization scale showed high reliability ($\alpha = .79$).

Perceived Stress Scale (PSS)—The PSS⁵⁷ measures how one interprets the stressfulness of events that have occurred in the month prior to completing the Scale, and which consists of 10 items. Participants indicated the frequency with which they experienced stressful emotions on a 5-point scale that ranges from 0 (“never”) to 4 (“very often”). All 10 items were summed, producing a score that could range from 0 to 40. A higher score was indicative of a relatively higher level of stress and, in the present sample, the PSS demonstrated high reliability ($\alpha = .91$).

Beck Depression Inventory-II (BDI-II)—The BDI-II⁵⁸ was used to assess depressive symptomatology. It consists of 21 items to which respondents can choose 1 of 4 response options, that range from 0 to 3. The responses to each item are totaled to calculate a possible maximum score of 63. Higher scores indicate more severe levels of depressive symptoms and, in the present sample, the BDI-II rendered high reliability ($\alpha = .92$).

Short-Form 36—The SF-36⁵⁹ is a health survey of 36 items that evaluates individuals' quality of life as a result of their current health. It consists of 8 scales, which measure different facets of health as related to both physical and mental wellness. Scores range from 0 to 100, with higher scores indicating a greater improvement in well being. In the present sample, this measure had high reliability ($\alpha = .94$).

Chewing Pain—In order to obtain a measure of functional pain, participants were asked to chew 5 tablets of an artificial test food material (i.e., CutterSil®). After chewing the fifth tablet, participants were asked to indicate which side of their mouth felt most uncomfortable during chewing, and to rate their level of chewing pain from 0 (“no pain”) to 10 (“pain as bad as could be”) for both sides. Because the TMD literature does not suggest one side of the mouth being more prone to pain than the other side, the pain rating was taken from the least comfortable side of the mouth. In the event that a participant indicated that both sides were equally uncomfortable, an average of the two pain ratings was used.

Masticatory Performance—As explained above, participants were given five tablets of CutterSil® to chew in order to ascertain each participant's level of masticatory performance. CutterSil® is a standardized, artificial test food material that consists of condensed silicone with negligible flavor, scent, or absorptive properties; these characteristics make CutterSil® a superb material for evaluating functionality in terms of mastication.⁶⁰ This is done with median particle size and broadness of distribution of the CutterSil®. Median particle size is measured in millimeters, and gives an indication of masticatory performance, with a small level indicative of adequate breakdown of the test food material, which can give some indication of better nutritive absorption later on in the digestive process.⁷ The broadness of distribution measure serves as an indication of the variance of the sample; a small level, which is associated with a wider distribution, indicates superior masticatory performance.⁶¹ For more details on the development and assessment of CutterSil®, the reader is directed elsewhere.⁶¹

Procedure

After the participants formally consented and were deemed eligible for the study, the baseline evaluation was completed, which included the aforementioned assessments. Once the baseline evaluation was administered, each participant's at-risk status was determined by using the earlier discussed algorithm.²⁶ Participants were then categorized into either low- or high-risk for chronic TMD. This method has produced 91% correct classification rates among chronic TMD patients.²⁶ If participants were determined to be at a low-risk for developing chronic TMD, they were assigned to the LR/NI group. If participants were determined to be at a high-risk for developing chronic TMD, they were randomized into one of two intervention groups: the HR/BB or the HR/SC. During the intervention phase, the HR/BB group received a biobehavioral intervention, which included cognitive behavioral treatment techniques, as well as biofeedback. The HR/SC group received a self-care intervention, which included educational materials on the management of TMD (see Figure 1). The intervention phase included 6 sessions that lasted for about 3 weeks, depending on the participant's schedule and, afterwards, a series of post-intervention follow-up evaluations were administered to all participants. These post-intervention evaluations occurred immediately after the intervention, one-year after the intervention, and two-years after the intervention (Figure 2).

Data Analyses

The aforementioned outcome measures were assessed across the four major time points: pre-intervention; immediate post-intervention; one-year follow-up; and two-year follow-up. Also, the participants were grouped based on both the RDC/TMD Axis I diagnosis determined at pre-intervention, as well as their treatment group: LR/NI; HR/BB; HR/SC. Analyses consisted of two-level hierarchical multilevel models (MLMs). These models were chosen over traditional ANOVA models because they handle missing and unbalanced repeated-measures data, and model between- and within-subjects effects. Calculation of intraclass correlation coefficients for the models, that included only the random intercept, confirmed that a substantial amount of variance (21–67%) in each outcome was attributable to the second-level factors, confirming that MLM was an appropriate statistical strategy (see Tables 2a and 2b for Psychosocial Outcomes, and the Pain and Functional Outcomes, respectively). As in a traditional ANOVA, the interest was on comparing categorical group differences on mean symptom reports. Therefore, only the fixed effects of the independent variables were examined, specifically the between-subjects effects of diagnosis group and treatment group, the within-subjects effect of time, and the resulting two-way and three-way interactions. To better fit the data, the models included random intercepts and used a heterogenous autoregressive covariance matrix to model the effect of time. The full MLM equation was

$$\begin{aligned}
 Y_{ij} = & \gamma_{00} + \gamma_{10} \textit{Time} \\
 & + \gamma_{01} \textit{Group} \\
 & + \gamma_{02} \textit{Diagnosis} \\
 & + \gamma_{03} \textit{Group} \times \textit{Diagnosis} \\
 & + \gamma_{11} \textit{Time} \times \textit{Group} \\
 & + \gamma_{12} \textit{Time} \times \textit{Diagnosis} \\
 & + \gamma_{13} \textit{Time} \times \textit{Group} \times \textit{Diagnosis} \\
 & + u_{0j} + e_{ij}
 \end{aligned}$$

The following models were examined: intercepts only; main effects of time, diagnosis group, and treatment group (all fixed effects); all possible two-way interactions; and the fourth model that added the three-way interaction among diagnosis group, treatment group, and time. This fourth model tested the primary hypothesis that the effects of treatment would vary over time for the different diagnostic groups. However, none of the models, including the three-way interaction, fit the data, and so were not reported. There was still interest in examining the direct effects of diagnosis, as well as whether diagnostic group moderated the effects of time or the effects of treatment group (regardless of time). Therefore, only the effects involving diagnostic group are reported, even though all analyses did include treatment group and Treatment Group $\times$ Time to control for their effects. Readers are referred to a previous report for the findings related to treatment group over time.²¹ For simplicity, only the models at the highest level are reported. Post-hoc analyses, using a Bonferroni correction for multiple comparisons, were conducted to determine which levels of the variables were different from one another. As was expected, there were no significant differences among the demographic variables across the conditions of the study (see Table 1).

RESULTS

Contrary to expectations, the main hypotheses were not supported and TMD diagnostic group did not moderate the effects of treatment group over time. However, the other effects involving diagnostic group were of interest and are reported below while controlling for the effects of time and treatment group by time that were reported previously.²¹

Psychosocial Distress

In order to assess the effects of the different interventions on psychosocial distress (perceived stress, depressive symptoms, mental health quality of life, and non-painful somatization) in terms of TMD diagnoses, a series of MLMs were conducted to determine the best fit for the data (see Tables 2a, 3 and 4). Reports of perceived stress differentially changed over time as a function of diagnosis (i.e., Diagnosis Group $\times$ Time). As expected, simple effects analyses revealed that, at Pre-Intervention, patients with m-TMD reported more perceived stress than did patients diagnosed with degenerative joint disease, multiple diagnoses excluding m-TMD, or no diagnosis. Patients with multiple diagnoses (including m-TMD) also reported more perceived stress at pre-intervention than did patients with no diagnoses. However, there were no differences among the diagnostic groups at any other

time point. Additionally, simple effects of time revealed that reports of perceived stress decreased from Pre-Intervention to all later assessments for patients diagnosed with m-TMD and multiple diagnoses including m-TMD, as well as for patients diagnosed with disc displacement. Furthermore, there were main effects of diagnosis (averaging across the four assessments) on mental health quality-of-life and non-painful somatization. As expected, patients diagnosed with m-TMD and multiple diagnoses (including m-TMD) reported poorer mental health quality-of-life than patients with multiple diagnoses excluding m-TMD. Additionally, patients diagnosed with m-TMD reported more non-painful somatization than did patients with degenerative joint disease or no diagnosis. In contrast, there were no differences in reports of depressive symptoms by diagnosis group.

Pain

To assess the differential treatment effects on pain according to TMD diagnoses, MLMs were conducted (see Table 2b). There were significant main effects of diagnosis group on all measures of pain (averaging across time and treatment group): self-reported pain; chewing pain; painful somatization; and pain-related disability (see Tables 5 and 6). In general, participants with a m-TMD diagnosis alone, or in combination with other diagnoses, tended to report more pain than did participants with some of the other diagnoses. Participants with multiple diagnoses including m-TMD reported higher levels of all types of pain than did participants with no diagnoses. They also reported more pain during chewing and pain-related disability than did participants with degenerative joint disease, and they reported more pain during chewing than did participants with m-TMD only. In addition, participants with a m-TMD diagnosis reported more painful somatization than did participants with degenerative joint disease or no diagnoses.

Functionality

To assess the effects of treatment on functionality as it pertains to TMD diagnoses, MLMs were conducted examining physical quality-of-life and masticatory performance as the median particle size and broadness of distribution measure (see Tables 2b, 7, and 8). Participants with a m-TMD diagnosis had worse masticatory performance for both the multiple particle size and broadness of distribution measures, when compared to patients without this diagnosis (i.e., a main effect of diagnosis averaged across time and treatment group). Moreover, m-TMD diagnosis patients had worse broadness of distribution chewing performance outcomes when compared to those with multiple diagnoses including a m-TMD. There were also differences among the diagnosis group within each of the treatment groups (i.e., Diagnosis Group $\times$ Treatment Group). Specifically, within the HR/BB treatment group, participants with multiple diagnoses excluding m-TMD had poorer performance as assessed by the median particle size measure ($M = 5.31$, $SE = 0.65$) than did those with disc displacement ($M = 2.91$, $SE = 0.43$). However, within the HR/SC arm, participants with either m-TMD or multiple diagnoses including m-TMD had poorer performance as assessed by the multiple particle size measure ($M = 4.46$, $SE = 0.25$; $M = 3.91$, $SE = 0.15$, respectively), than did the participants with no diagnosis ($M = 2.86$, $SE = 0.23$). There were no differences among the diagnosis groups within the LR/NI group. Additionally, there were no differences in physical quality-of-life among the diagnosis groups.

DISCUSSION

As reviewed earlier, the present study was part of the first large-scale investigation to evaluate whether a biobehavioral intervention for acute TMD, found to be efficacious in academic clinical settings, could be effectively implemented in community-based clinics. Previously, we reported that both biobehavioral and self-care interventions were effective, among patients at high-risk for developing chronic TMD, for improving outcomes related to psychosocial issues, pain, and functionality.²¹ The current investigation specifically assessed whether a biobehavioral intervention would be more effective for patients with m-TMD, relative to other TMD sub-groups receiving either a self-care intervention or no intervention. Overall, the present study found that the effects of the biobehavioral and self-care interventions did not differ based on the patients' diagnosis, suggesting that these interventions can be applied to all types of TMD patients. Much like the current study, Mora, Weber, Neff, and Rief³⁸ compared two different treatment groups (i.e., one included both cognitive-behavioral treatment and biofeedback, and the other involved the application of splints) in TMD patients. It was found that patients reported improvements in psychosocial distress over time, yet group differences were not found. In two separate studies, Dworkin and colleagues^{1, 20} found that TMD patients who were and were not treated for their symptoms did not differ in terms of depressive symptoms and somatization, which they suspected may have been due to the lack of specificity in the cognitive-behavioral therapy approach used to address these issues, as well as to the fact that the same study personnel assessed both groups. Furthermore, Dworkin and colleagues¹ posited that such psychosocial dysfunctions may need more rigorous cognitive behavioral treatment-type approaches in order to produce noticeable improvements when comparisons are made to patients not receiving treatment. It should be kept in mind, though, that many of these studies did not evaluate "high-risk" patients who were assessed in the present investigation. Therefore, a word of caution should be raised in attempting to compare results across studies.

The one important new finding, though, of the present investigation was that there were important differences among the diagnosis groups for the psychosocial, pain, and functioning outcomes that may be used to better "tailor" future interventions to specific patient needs. In particular, patients with m-TMD either alone or in combination with other diagnoses tended to report worse outcomes than the other diagnosis groups. Given the high levels of pain and dysfunction that m-TMD sufferers report,^{2, 36, 53, 62, 63} it was expected that such reports would be indicative of psychosocial distress. Indeed, it was found that patients with m-TMD either alone or in combination with other diagnoses reported greater perceived stress before the intervention and quickly recovered to lower levels during the follow-up assessments. Patients with disc displacement followed a similar pattern. Patients with any type of m-TMD also reported poorer mental health quality-of-life than did patients with multiple diagnoses excluding m-TMD. Patients with m-TMD alone also reported greater somatization than other participants.

Contrary to past research findings, which suggested that a biobehavioral intervention is beneficial for patients with TMD in relieving psychosocial distress,⁴³ the current study did not find that the biobehavioral intervention was as effective in reducing stress, depressive symptoms, and somatization, or in improving mental wellness, for m-TMD patients, relative

to the other m-TMD participants evaluated (HR/SC and LR). It was also not found that biobehavioral intervention patients with a single diagnosis of m-TMD improved relative to patients with multiple diagnoses including a muscle disorder. This was not totally surprising in light of the report of Velly and colleagues⁴² that patients with orofacial pain report many psychosocial comorbidities, including anxiety, depression and somatization. Also, the findings from the earlier cited study by Dahan and colleagues⁴⁴ revealed more comorbid migraine and chronic fatigue syndrome disorders in m-TMD patients. Thus, these may be especially more prevalent in m-TMD patients, requiring an even more comprehensive treatment plan for them above- and beyond-the biobehavioral intervention provided in the present investigation.

Relatedly, it is also noteworthy that a preliminary study found that there were no differences with regard to pain and masticatory functioning between depressed and non-depressed TMD participants.⁷ It was suggested that depressed TMD patients have quite possibly become “desensitized” to their TMD-related symptoms.⁷ Also, in yet another preliminary study, Lorduy and colleagues³⁰ found no differences between the intervention groups with regard to depressive symptoms or mental well-being (as measured by the SF-36). Unfortunately, in these studies, a breakdown by diagnosis (especially for m-TMD) was not evaluated.

Because TMD is typically regarded as a chronic pain condition, it was natural to expect that an early intervention program would be effective in reducing pain, particularly for patients with m-TMD because these patients tend to suffer inordinately from pain.^{36, 53, 63} Indeed, patients with multiple diagnoses including m-TMD reported greater pain in all four pain measures than some of the other participants. While these patients reported improvements in chewing pain from baseline to all of the follow-up assessments, they continued to report higher levels of chewing pain at all four assessments. Notably, patients with combination of m-TMD and other TMD diagnoses reported more chewing pain than patients who were diagnosed with m-TMD alone, a finding that supports the idea that combination diagnoses, especially those that involve a muscle disorder, produce more severe symptom presentations.

Unfortunately, a reduction was not found in facial pain, painful somatization, or pain-related disability for m-TMD patients receiving the biobehavioral intervention in comparison to other participants. This outcome is similar to the earlier laboratory findings in the scientific literature. For instance, Mishra, Gatchel, and Gardea²⁸ found that there were no differences in treated versus non-treated TMD patients with regard to pain-related disability. It was speculated that the emphasis on psychosocial techniques in the biobehavioral intervention may have conflicted with the patients' physiological view of their disorder, thereby hindering the intervention's efficacy. In that same year, Bernstein and Gatchel²⁷ found no difference between treatment groups in orofacial pain, and they suggested that the measure used to gauge facial pain (i.e., the Characteristic Pain Inventory measure) may have been lacking in sensitivity. Likewise, in another laboratory study, Lorduy and colleagues³⁰ found no differences between the intervention groups for orofacial pain or pain-related disability. This discrepancy in the findings among the different pain measures may also have been due to the fact that chewing pain was tied to a function for which patients had an immediate reference (i.e., the report of chewing pain was given directly after the chewing task), whereas the reports of facial pain, painful somatization, and pain-related disability were likely not as

immediately experiential. More importantly, however, was the fact that of the different TMD categories above, only m-TMD appears to require more intensive intervention. This was not provided in these earlier studies.

Other studies have found null results in regard to non-functional pain. In one investigation, Michelotti and colleagues⁵¹ found that patients with m-TMD, who received physical therapy in addition to education, were not different from controls in terms of pain intensity or pain pressure thresholds. In addition, a review conducted by Crider, Glaros and Gervitz¹⁰ discussed various findings^{64, 65} relating to biofeedback training to reduce pain over time. However, there were no differences between patients receiving biofeedback and those not receiving it, which the authors suggested may have been due to some methodological issues. Furthermore, Dworkin and colleagues^{1, 20} also compared groups of TMD patients who were either in a treatment group or in a control group, whereas Mora and colleagues³⁸ compared two different treatment groups of TMD patients. Both studies found that, although there was a reduction in pain over time, the groups did not differ in pain or pain-related disability which, once again, was ascribed to a lack of specificity of the cognitive-behavioral treatment. It should be noted, however, that in the present study, even though a standard cognitive-behavioral treatment protocol was used, it was further specifically-tailored to the needs of particular patients. Again, however, as noted earlier, it should be kept in mind that the present study evaluated “high-risk” patients. Other studies have not, making comparisons between them difficult.

Finally, past research has shown that the presence of m-TMD disrupts one's ability to function properly.^{28, 41, 53, 62, 66} This was supported by the finding in the current study that the patients with m-TMD alone reported poorer masticatory performance than participants with either multiple diagnoses including m-TMD or participants with no diagnoses. This deficiency in functionality was hypothesized to extend beyond mastication, and that a biobehavioral intervention could provide relief. It was revealed that median particle size and broadness were worse for participants with a m-TMD diagnosis only. Additionally, high-risk MD patients receiving the self-care intervention had larger median particle sizes (poorer masticatory performance) when compared to participants with m-TMD who were in the low-risk non-intervention group. Other studies have found similar results. For instance, Wright and colleagues¹³ found that there were no differences in chewing performance at the end of treatment between HR and LR patients with acute TMD. Sanders et al⁶⁷ also found that there were no differences in masticatory performance between the HR groups who were receiving treatment. Furthermore, Dougall and colleagues²⁹ found that HR acute TMD patients, as well as patients with multiple RDC/TMD Axis I diagnoses, did not differ from LR acute TMD patients and patients without multiple diagnoses, respectively, with regard to masticatory performance. Again, the HR patients receiving either of the interventions began functioning as well as the less problematic LR patients following treatment. Considering these findings, in addition to the fact that the two interventions did not yield differences with regard to masticatory performance, it can be speculated that CutterSil® may not have been able to detect such differences. In particular, CutterSil® helps identify treatment differences related to occlusion (P. Buschang, personal communication, February 2015), which is the alignment of the teeth when both the top and bottom jaws are in contact and, therefore, dictates the chewing pattern.⁶⁸ The CutterSil® assessments used in the present study may

not have produced significant effects because the treatments provided were either therapeutic or educational for TMD pain in general, as opposed to involving a method that could affect occlusion more directly (e.g., manual therapy).

One other minor limitation of the current study was that the diagnostic criteria for TMD were revised while the study was still in progress. Therefore, care must be taken in interpreting the diagnostic information gathered from the RDC/TMD. The RDC/TMD are not meant to be used as an exhaustive, singular diagnostic tool for every type of TMD, orofacial pain, or psychiatric condition.⁶⁹ Instead, it is intended to provide the first step of a replicable, standardized method of identifying and classifying subgroups of TMD, using a biopsychosocial perspective.⁷⁰ Consequently, now that this first step has been established, a newer version of the RDC/TMD has been created -- Diagnostic Criteria for Temporomandibular Disorder (DC/TMD) -- and has great promise to expand upon the success of its predecessor. Indeed, following the release of the original RDC/TMD, great strides were made in pain research and, as a result, new assessments and constructs were created.⁷⁰ These advances then led to a quest for improving how the RDC/TMD could better assess TMD.⁷⁰ In 2001, a group of researchers engaged in a 7-year validation project, which consisted of a series of 6 studies.^{34, 46, 71–74} After the culmination of these studies, the RDC/TMD were revised, and the name was changed to the DC/TMD.⁷⁰ New diagnostic criteria were released on February 3rd, 2014, and are intended to: assess TMD to a greater extent than did the RDC/TMD; clarify the interpretation of the diagnostic information; and be used in both research and clinical settings.⁷⁰ In fact, the original creators of the RDC/TMD did forewarn that the assessment tool would need further revisions to increase accuracy and validity,⁷⁰ and these revisions have culminated in the new DC/TMD, which are vastly different from the RDC/TMD. Most notably, the somatization measures have been removed, and the items that measured orofacial pain and pain-related disability have changed their time references, from the past 6 months to now the past 30 days. Such changes would have likely altered the results of the current study, especially considering the fact that the outcome measures that were either altered or removed were the very ones that rendered null findings.

Although many findings of the present investigation did not reveal significant differences between the two intervention groups, there may be an overarching reason to explain this. For instance, some researchers have found that patients who have good rapport with healthcare professionals, and who are able to receive professional guidance and have their concerns listened to and addressed, tend to produce favorable outcomes in terms of a reduction in TMD symptoms.¹ This may have been a significant therapeutic component for the self-care intervention group. Another potential limitation is the possibility of “regression towards the mean.” The hypotheses posited that the most improvement would occur in subgroups of patients that were expected to have the worst outcomes. It should be emphasized that all of the necessary precautions were taken to combat this potential confound: the groups were randomly assigned; repetitive assessments were administered; and a large dataset was used.⁷⁵ Interestingly, in a long-term study, Ohrbach and Dworkin⁷⁶ found that about one-half of the TMD patients in their study remitted (i.e., reported an absence of pain) at a five-year follow-up, which suggests that TMD pain may be cyclical in nature and resolve on its own.^{63, 77} However, additional research on this issue is still needed.

In conclusion, the overall purpose of the current study was to build upon past research, conducted in academic clinical settings, which showed that early interventions, particularly those that are biobehavioral, were efficacious for HR acute TMD patients. It was also the first large-scale translational investigation undertaken to examine the effectiveness of these interventions when they were implemented in community-based clinics. Overall, the results did support the success of this translation through the use of subgroup analyses, which assessed the treatment effects according to the diagnoses given to patients prior to their respective interventions. Overall, the current study was able to show the following: early interventions are effective in HR acute TMD populations; m-TMD tends to result in more severe symptom presentations, particularly if diagnosed in combination with other TMD diagnoses; TMD-related symptoms tend to decrease over time; and, most importantly, the effectiveness of a biobehavioral intervention varies based on diagnoses. Other important contributions of studies such as this have been further highlighted by Dougall and colleagues.²¹ Such contributions reinforce Sessle's⁷⁸ recent conclusion that: "...along with advances in ensuring better knowledge transfer to and application by clinicians, significant improvements in the diagnostic and management approaches will be made that will alleviate the pain and suffering of many patients with, or at risk for, a chronic orofacial pain condition." (p.495).

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Figure 1.
Comparison of HR/BB and HR/SC interventions

Figure 2.
Participant Flowchart

Table 1Demographic Characteristics (*N* = 435)

Variable	HR/BB, <i>n</i> = 168		HR/SC, <i>n</i> = 131		LR/NI, <i>n</i> = 136		<i>X</i> ² / <i>F</i>	<i>df</i>	<i>p</i>
	<i>n/M</i>	(%)/(<i>SD</i>)	<i>n/M</i>	(%)/(<i>SD</i>)	<i>n/M</i>	(%)/(<i>SD</i>)			
Education ^{†*}	15.33	(2.17)	15.09	(2.29)	15.27	(2.25)	.46	2, 425	.63
Age ^{†*}	44.14	(14.99)	42.95	(14.41)	44.61	(17.95)	.39	2, 430	.68
Race							4.41	8	.82
Caucasian	119	(70.8)	92	(70.2)	93	(68.4)			
Latino/a	21	(12.5)	13	(9.9)	18	(13.2)			
African	17	(10.1)	17	(13)	17	(12.5)			
American									
Asian	5	(3)	6	(4.6)	2	(1.5)			
Other	6	(3.6)	3	(2.3)	6	(4.4)			
Gender							2.07	2	.36
Male	30	(17.9)	25	(19.1)	33	(24.3)			
Female	138	(82.1)	106	(80.9)	103	(75.7)			
Marital Status							14.94	8	.06
Single	52	(31)	37	(28.2)	49	(36)			
Married	92	(54.8)	70	(53.4)	65	(47.8)			
Divorced or Separated	20	(11.9)	21	(16)	14	(10.3)			
Widowed	4	(2.4)	3	(2.3)	3	(2.2)			
Not					5	(3.7)			
Reported									
Combined							2.96	8	.94
Household									
Income ^{†*}									
\$0–14,999	16	(9.5)	16	(12.2)	14	(10.3)			
\$15,000–24,999	12	(7.1)	12	(9.2)	10	(7.4)			
\$25,000–34,999	14	(8.3)	10	(7.6)	15	(11)			
\$35,000–49,999	17	(10.1)	10	(7.6)	10	(7.4)			
\$50,000 or more	106	(63.1)	78	(59.5)	80	(58.8)			

[†] this variable is measured in terms of years;^{*} this variable has system missing values

Table 2a**Model Fit and Improvement for the Psychosocial Outcome Variables**

Outcome	Parameters	-2 Log Likelihood	X ² Difference Test or ICC
Psychosocial Outcomes			
Perceived Stress (<i>N</i> = 435; Observations = 1184)			
Intercept Only	3	7598.47	ICC = .65
Main Effects	17	7518.09	X ² (14) = 80.383, <i>p</i> < .001
Two-way Interactions	48	7463.46	X ² (31) = 54.63, <i>p</i> = .005
Three-way Interaction	77	7447.73	X ² (29) = 15.732, <i>p</i> = .98
Depressive Symptoms (<i>N</i> = 434; Observations = 1159)			
Intercept Only	3	7503.43	ICC = .67
Main Effects	17	7369.08	X ² (14) = 134.35, <i>p</i> < .001
Two-way Interactions	48	7311.67	X ² (31) = 57.40, <i>p</i> = .003
Three-way Interaction	77	7278.28	X ² (29) = 33.40, <i>p</i> = .26
Mental Health Quality of Life (<i>N</i> = 434; Observations = 1186)			
Intercept Only	3	8684.74	ICC = .51
Main Effects	17	8590.50	X ² (14) = 94.24, <i>p</i> < .001
Two-way Interactions	48	8560.03	X ² (31) = 30.47, <i>p</i> = .49
Three-way Interaction	77	8538.21	X ² (29) = 21.82, <i>p</i> = .83
Nonpainful Somatization (<i>N</i> = 435; Observations = 1186)			
Intercept Only	3	1551.74	ICC = .61
Main Effects	17	1458.45	X ² (14) = 93.29, <i>p</i> < .001
Two-way Interactions	48	1412.52	X ² (31) = 45.93, <i>p</i> = .04
Three-way Interaction	77	1382.64	X ² (29) = 29.88, <i>p</i> = .42

ICC = Intraclass correlation coefficient

Table 2b**Model Fit and Improvement for the Pain and Functional Outcomes**

Outcome	Parameters	-2 Log Likelihood	X ² Difference Test or ICC
Pain Outcomes			
Self-reported Pain (<i>N</i> = 435; Observations = 1188)			
Intercept Only	3	11129.66	ICC = .21
Main Effects	17	10214.46	X ² (14) = 915.20, <i>p</i> < .001
Two-way Interactions	48	10076.79	X ² (31) = 137.68, <i>p</i> < .001
Three-way Interaction	77	10055.58	X ² (29) = 21.21, <i>p</i> = .85
Chewing Pain (<i>N</i> = 424; Observations = 1126)			
Intercept Only	3	5153.80	ICC = .46
Main Effects	17	4797.82	X ² (14) = 355.98, <i>p</i> < .001
Two-way Interactions	48	4711.23	X ² (31) = 86.60, <i>p</i> < .001
Three-way Interaction	77	4673.46	X ² (29) = 37.77, <i>p</i> = .13
Painful Somatization (<i>N</i> = 435; Observations = 1186)			
Intercept Only	3	1590.05	ICC = .65
Main Effects	17	1481.43	X ² (14) = 108.62, <i>p</i> < .001
Two-way Interactions	48	1432.24	X ² (31) = 49.20, <i>p</i> = .02
Three-way Interaction	77	1408.15	X ² (29) = 24.08, <i>p</i> = .73
Pain-Related Disability (<i>N</i> = 435; Observations = 1187)			
Intercept Only	3	3208.29	ICC = .25
Main Effects	17	2591.98	X ² (14) = 616.31, <i>p</i> < .001
Two-way Interactions	48	2455.28	X ² (31) = 136.70, <i>p</i> < .001
Three-way Interaction	77	2433.33	X ² (29) = 21.95, <i>p</i> = .82
Functional Outcomes			
Physical Quality of Life (<i>N</i> = 434; Observations = 1186)			
Intercept Only	3	8151.78	ICC = .61
Main Effects	17	8082.40	X ² (14) = 69.38, <i>p</i> < .001
Two-way Interactions	48	8029.58	X ² (31) = 52.82, <i>p</i> = .01
Three-way Interaction	77	7995.35	X ² (29) = 34.23, <i>p</i> = .23
Median Particle Size (<i>N</i> = 425; Observations = 1078)			
Intercept Only	3	3202.41	ICC = .64
Main Effects	17	3084.07	X ² (14) = 118.34, <i>p</i> < .001
Two-way Interactions	48	3029.11	X ² (31) = 54.96, <i>p</i> = .005
Three-way Interaction	77	3003.94	X ² (29) = 25.17, <i>p</i> = .67
Broadness (<i>N</i> = 425; Observations = 1078)			
Intercept Only	3	8465.01	ICC = .59
Main Effects	17	8306.95	X ² (14) = 158.06, <i>p</i> < .001
Two-way Interactions	48	8274.97	X ² (31) = 31.98, <i>p</i> = .42
Three-way Interaction	77	8243.88	X ² (28) = 31.09, <i>p</i> = .31

ICC = Intraclass correlation coefficient

Table 3

Significance Tests for the Fixed Effects in the Final Multilevel Models by Psychosocial Outcomes

Outcome	Effect from Final Model	Significance Test
Perceived Stress		
	Diagnosis Group	$F(5, 439.91) = 2.76, p = .02$
	Treatment Group	$F(2, 433.46) = 0.02, p = .98$
	Time	$F(3, 267.45) = 7.52, p < .001$
	Diagnosis Group $\times$ Treatment Group	$F(10, 422.20) = 531.00, p = .87$
	Diagnosis Group $\times$ Time	$F(15, 270.83) = 2.18, p = .01$
	Treatment Group $\times$ Time	$F(6, 270.56) = 1.81, p = .10$
Depressive Symptoms		
	Diagnosis Group	$F(5, 411.54) = 2.18, p = .06$
	Treatment Group	$F(2, 413.40) = 0.07, p = .93$
	Time	$F(3, 263.32) = 11.26, p < .001$
	Diagnosis Group $\times$ Treatment Group	$F(10, 407.99) = 0.93, p = .51$
	Diagnosis Group $\times$ Time	$F(15, 280.39) = 1.53, p = .10$
	Treatment Group $\times$ Time	$F(6, 259.75) = 3.01, p = .01$
Mental Health Quality of Life		
	Diagnosis Group	$F(5, 393.23) = 3.27, p = .01$
	Treatment Group	$F(2, 407.47) = 0.10, p = .91$
	Time	$F(3, 286.25) = 16.16, p < .001$
Non-painful Somatization		
	Diagnosis Group	$F(5, 389.06) = 4.60, p < .001$
	Treatment Group	$F(2, 402.14) = 0.79, p = .45$
	Time	$F(3, 288.77) = 1.81, p = .15$
	Diagnosis Group $\times$ Treatment Group	$F(10, 391.47) = 0.92, p = .51$
	Diagnosis Group $\times$ Time	$F(15, 292.65) = 0.74, p = .75$
	Treatment Group $\times$ Time	$F(6, 288.92) = 2.90, p = .01$

Table 4

Means and Standard Errors by Diagnosis and Time for the Psychosocial Outcomes.

Outcome	No RDC/TMD Axis I Diagnosis			Muscle Disorder			Disc Displacement			Degenerative Joint Disorder			Multiple Diagnoses Including Muscle			Multiple Diagnoses Excluding Muscle		
	M	SE		M	SE		M	SE		M	SE		M	SE		M	SE	
Perceived Stress																		
Pre-Intervention	12.88 ^{a,d}	0.81		17.33 ^{a,b,c,1,2,3}	0.76		18.13 ^{1,2,3}	1.60		13.33 ^b	1.08		16.68 ^{d,1,2,3}	0.56		9.82 ^c	2.36	
Post-Intervention	13.60	0.88		15.11 ¹	0.81		12.91 ¹	1.75		12.55	1.11		14.41 ¹	0.62		9.65	2.43	
One Year	13.45	0.98		14.32 ²	0.88		11.33 ²	2.09		11.41	1.26		13.66 ²	0.70		9.08	2.68	
Two Years	14.05	1.10		15.24 ³	0.88		12.18 ³	2.15		11.20	1.37		14.14 ³	0.70		11.19	2.74	
Total	13.49	0.76		15.50	0.70		13.64	1.52		12.12	0.98		14.73	0.53		9.94	2.18	
Depressive Symptoms																		
Pre-Intervention	5.72	0.87		9.78	0.81		8.17	1.73		6.74	1.16		9.98	0.60		4.30	2.51	
Post-Intervention	5.22	0.89		7.06	0.81		4.53	1.76		5.80	1.12		6.76	0.62		3.07	2.45	
One Year	5.25	0.98		6.18	0.89		2.97	2.04		4.13	1.25		6.15	0.68		2.65	2.72	
Two Years	5.22	1.06		6.67	0.86		1.63	2.03		4.34	1.30		5.67	0.68		3.06	2.65	
Total	5.35	0.78		7.43	0.71		4.33	1.53		5.26	1.00		7.14	0.53		3.27	2.22	
Mental Health Quality of Life																		
Pre-Intervention	48.23	1.22		44.08	1.14		45.70	2.44		49.61	1.66		45.49	0.85		55.95	3.56	
Post-Intervention	50.18	1.31		48.22	1.20		50.61	2.60		51.28	1.61		49.00	0.91		57.59	3.51	
One Year	49.73	1.43		49.56	1.29		51.75	3.08		52.79	1.82		49.98	1.01		58.47	3.73	
Two Years	47.92	1.53		46.88	1.19		54.63	2.97		52.54	1.88		49.87	0.95		55.78	3.78	
Total	49.01	1.03		47.18 ^a	0.93		50.67	2.05		51.55	1.30		48.58 ^b	0.71		56.95 ^{a,b}	2.93	
Non-painful Somatization																		
Pre-Intervention	0.30	0.06		0.60	0.06		0.21	0.12		0.32	0.08		0.60	0.04		0.19	0.18	
Post-Intervention	0.25	0.07		0.52	0.06		0.27	0.13		0.26	0.08		0.46	0.05		0.13	0.18	
One Year	0.30	0.07		0.51	0.06		0.32	0.15		0.22	0.09		0.39	0.05		0.11	0.19	
Two Years	0.20	0.08		0.43	0.06		0.21	0.15		0.25	0.10		0.36	0.05		0.09	0.20	
Total	0.26 ^a	0.05		0.52 ^{a,b}	0.05		0.25	0.11		0.26 ^b	0.07		0.45	0.04		0.13	0.15	

Note: Means with the same superscript are different at $p < .05$. Roman letters indicate differences within rows and Roman numbers indicate differences within columns.

Table 5
Significance Tests for the Fixed Effects in the Final Multilevel Models by Pain Outcomes

Outcome	Effect from Final Model	Significance Test
Self-reported Pain		
	Diagnosis Group	$F(5, 440.75) = 4.09, p = .001$
	Treatment Group	$F(2, 538.88) = 28.17, p < .001$
	Time	$F(3, 336.28) = 116.07, p < .001$
	Diagnosis Group $\times$ Treatment Group	$F(10, 443.98) = 1.71, p = .08$
	Diagnosis Group $\times$ Time	$F(15, 340.91) = 1.50, p = .10$
	Treatment Group $\times$ Time	$F(6, 337.54) = 17.44, p < .001$
Chewing Pain		
	Diagnosis Group	$F(5, 404.65) = 8.44, p < .001$
	Treatment Group	$F(2, 404.23) = 2.57, p = .08$
	Time	$F(3, 259.71) = 31.86, p < .001$
	Diagnosis Group $\times$ Treatment Group	$F(10, 380.53) = 1.68, p = .08$
	Diagnosis Group $\times$ Time	$F(15, 270.91) = 2.14, p = .01$
	Treatment Group $\times$ Time	$F(6, 254.11) = 5.08, p < .001$
Painful Somatization		
	Diagnosis Group	$F(5, 411.05) = 5.76, p < .001$
	Treatment Group	$F(2, 414.56) = 0.75, p = .47$
	Time	$F(3, 262.15) = 3.91, p = .01$
	Diagnosis Group $\times$ Treatment Group	$F(10, 407.11) = 0.97, p = .47$
	Diagnosis Group $\times$ Time	$F(15, 265.25) = 0.86, p = .61$
	Treatment Group $\times$ Time	$F(6, 262.29) = 3.06, p = .01$
Pain Related Disability		
	Diagnosis Group	$F(5, 429.32) = 5.10, p < .001$
	Treatment Group	$F(2, 458.77) = 13.66, p < .001$
	Time	$F(3, 345.17) = 94.86, p < .001$
	Diagnosis Group $\times$ Treatment Group	$F(10, 417.84) = 1.28, p = .24$
	Diagnosis Group $\times$ Time	$F(15, 351.65) = 1.49, p = .11$
	Treatment Group $\times$ Time	$F(6, 347.08) = 17.31, p < .001$

Table 6

Means and Standard Errors by Diagnosis and Time for the Pain Outcomes.

Outcome	No RDC/TMD Axis I Diagnosis			Muscle Disorder			Disc Displacement			Degenerative Joint Disorder			Multiple Diagnoses Including Muscle			Multiple Diagnoses Excluding Muscle		
	M	SE		M	SE		M	SE		M	SE		M	SE		M	SE	
Self-reported Pain																		
Pre-Intervention	52.45	1.57		56.04	1.46		51.90	3.09		52.45	2.08		58.33	1.08		51.98	4.57	
Post-Intervention	35.09	2.73		35.78	2.50		28.93	5.54		37.33	3.41		44.53	1.91		41.21	7.22	
One Year	10.04	3.01		21.31	2.72		18.00	6.73		17.52	3.86		24.28	2.15		25.44	7.99	
Two Years	13.45	3.76		21.50	2.80		36.16	7.39		17.74	4.65		23.08	2.32		15.14	8.71	
Total	27.76 ^a	1.85		33.66	1.62		33.75	3.78		31.26	2.33		37.55 ^a	1.25		33.44	5.03	
Chewing Pain																		
Pre-Intervention	2.22 ^{a,b,c,1}	0.27		3.68 ^{a,d,1,2,3}	0.26		2.60 ^e	0.57		3.75 ^{b,1,2,3}	0.37		4.68 ^{c,d,e,1,2,3}	0.19		4.04 ¹	0.80	
Post-Intervention	1.82 ^{a,2}	0.29		2.16 ^{b,1}	0.27		1.64	0.61		2.32 ^{1,4,5}	0.35		3.23 ^{ab,1,4,5}	0.20		2.33	0.80	
One Year	0.99 ^{a,1,2}	0.27		1.70 ²	0.25		1.49	0.62		0.91 ^{b,2,5,4}	0.36		2.18 ^{ab,2,4}	0.20		1.91	0.72	
Two Years	1.33	0.38		1.60 ³	0.30		2.24	0.78		0.32 ^{a,3,5}	0.45		2.39 ^{a,3,5}	0.24		1.41 ¹	0.89	
Total	1.59 ^a	0.22		2.28 ^b	0.20		1.99	0.45		1.83 ^c	0.28		3.12 ^{a,b,c}	0.15		2.42	0.61	
Painful Somatization																		
Pre-Intervention	0.48	0.07		0.85	0.06		0.39	0.13		0.51	0.09		0.83	0.05		0.38	0.19	
Post-Intervention	0.43	0.07		0.72	0.06		0.47	0.13		0.39	0.08		0.65	0.05		0.21	0.18	
One Year	0.44	0.07		0.69	0.07		0.40	0.15		0.37	0.09		0.59	0.05		0.30	0.20	
Two Years	0.42	0.08		0.63	0.07		0.24	0.16		0.41	0.10		0.56	0.05		0.23	0.20	
Total	0.44 ^{a,c}	0.06		0.72 ^{a,b}	0.05		0.38	0.11		0.42 ^b	0.07		0.66 ^c	0.04		0.28	0.16	
Pain Related Disability																		
Pre-Intervention	1.70	0.07		1.88	0.07		1.61	0.14		1.73	0.09		2.03	0.05		1.81	0.21	
Post-Intervention	1.22	0.11		1.21	0.10		0.98	0.22		1.21	0.14		1.63	0.08		1.33	0.29	
One Year	0.51	0.11		0.83	0.10		0.54	0.23		0.60	0.13		0.90	0.08		0.79	0.28	
Two Years	0.48	0.14		0.92	0.10		1.34	0.27		0.60	0.17		0.89	0.09		0.38	0.32	
Total	0.98 ^a	0.07		1.21	0.06		1.12	0.14		1.03 ^b	0.09		1.36 ^{a,b}	0.05		1.08	0.20	

Note: Means with the same superscript are different at $p < .05$. Roman letters indicate differences within rows and Roman numbers indicate differences within columns.

Table 7
Significance Tests for the Fixed Effects in the Final Multilevel Models by Functional Outcomes

Outcome	Effect from Final Model	Significance Test
Physical Quality of Life		
Diagnosis Group	Diagnosis Group	$F(5, 420.27) = 1.92, p = .09$
	Treatment Group	$F(2, 417.25) = 3.37, p = .04$
	Time	$F(3, 269.22) = 3.26, p = .02$
Diagnosis Group $\times$ Treatment Group		
Diagnosis Group $\times$ Time	Diagnosis Group $\times$ Treatment Group	$F(10, 408.85) = 0.50, p = .89$
	Diagnosis Group $\times$ Time	$F(15, 273.88) = 0.86, p = .61$
	Treatment Group $\times$ Time	$F(6, 271.50) = 5.29, p < .001$
Median Particle Size		
Diagnosis Group	Diagnosis Group	$F(5, 448.02) = 3.14, p = .01$
	Treatment Group	$F(2, 466.20) = 1.32, p = .27$
	Time	$F(3, 258.72) = 6.69, p < .001$
Diagnosis Group $\times$ Treatment Group		
Diagnosis Group $\times$ Time	Diagnosis Group $\times$ Treatment Group	$F(10, 421.02) = 2.70, p = .003$
	Diagnosis Group $\times$ Time	$F(15, 266.16) = 1.20, p = .27$
	Treatment Group $\times$ Time	$F(6, 247.46) = 1.34, p = .24$
Broadness of Distribution		
Diagnosis Group	Diagnosis Group	$F(5, 429.82) = 4.05, p = .001$
	Treatment Group	$F(2, 457.23) = 2.69, p = .07$
	Time	$F(3, 274.58) = 10.30, p < .001$
Diagnosis Group $\times$ Treatment Group		
Diagnosis Group $\times$ Time	Diagnosis Group $\times$ Treatment Group	$F(10, 428.12) = 1.64, p = .09$
	Diagnosis Group $\times$ Time	$F(15, 267.82) = 0.56, p = .90$
	Treatment Group $\times$ Time	$F(6, 261.52) = 0.92, p = .48$

Table 8

Means and Standard Errors by Diagnosis and Time for the Functional Outcomes.

	No RDC/TMD Axis I Diagnosis		Muscle Disorder		Disc Displacement		Degenerative Joint Disorder		Multiple Diagnoses Including Muscle		Multiple Diagnoses Excluding Muscle	
	M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Physical Quality of Life												
Pre-Intervention	50.02	1.04	46.86	0.97	51.57	2.07	49.69	1.40	47.09	0.72	44.48	3.03
Post-Intervention	49.73	1.06	48.85	0.98	49.21	2.11	50.88	1.33	48.67	0.74	46.80	2.91
One Year	51.59	1.20	48.25	1.09	53.26	2.56	52.09	1.54	48.32	0.85	48.33	3.18
Two Years	51.18	1.29	49.60	1.03	51.67	2.50	50.92	1.59	49.14	0.81	49.09	3.21
Total	50.63	0.92	48.39	0.84	51.43	1.82	50.90	1.17	48.31	0.63	47.18	2.60
Median Particle Size (MPS)												
Pre-Intervention	3.59	0.14	4.06	0.13	3.81	0.28	3.93	0.18	3.99	0.10	4.55	0.40
Post-Intervention	3.49	0.16	4.16	0.15	3.40	0.33	3.98	0.21	3.84	0.11	4.89	0.45
One Year	3.12	0.17	3.97	0.16	3.42	0.39	3.59	0.23	3.70	0.12	3.95	0.55
Two Years	3.08	0.23	3.72	0.18	3.69	0.45	3.02	0.28	3.25	0.14	3.95	0.53
Total	3.32 ^a	0.14	3.98 ^a	0.13	3.58	0.29	3.63	0.18	3.70	0.09	4.33	0.39
Broadness of Distribution (BD)												
Pre-Intervention	12.12	1.59	20.07	1.51	18.08	3.33	15.77	2.17	16.48	1.11	26.95	4.73
Post-Intervention	13.27	1.86	20.34	1.72	14.76	3.82	16.17	2.40	15.16	1.30	30.35	5.31
One Year	10.44	1.79	16.29	1.63	13.01	4.06	10.82	2.31	11.34	1.26	19.49	5.78
Two Years	8.45	2.13	14.72	1.70	12.30	4.19	8.28	2.61	8.11	1.29	18.29	5.23
Total	11.07 ^a	1.44	17.86 ^{a,b}	1.31	14.54	2.98	12.76	1.86	12.77 ^b	0.98	23.77	4.24

Note: Means with the same superscript are different at $p < .05$. Roman letters indicate differences within rows and Roman numbers indicate differences within columns.