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*Review Article*

# Efficacy of cognitive-behavioral therapy for patients with temporomandibular disorder pain-systematic review of previous reports

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**Abstract:** Cognitive-behavioral therapy (CBT) was previously demonstrated to be the predominant psychological treatment for individuals with chronic pain conditions and is also thought to be effective for reducing pain in temporomandibular disorder (TMD) patients. We systematically reviewed randomized control trials (RCTs) performed to examine the effects of CBT on chronic pain in TMD patients. The PubMed search engine of the National Institutes of Health was employed to search for related studies published in English up to March 10, 2016. The initial search identified 138 reports, then following evaluation of the titles and abstracts, 57 publications were further screened according to the inclusion criteria. Next, we reviewed the full text of 28 RCTs, with 6 studies finally selected for this study. We could not perform a meta-analysis of the 6 RCTs because of the different CBT protocols and follow-up periods used in each study. However, meta-analysis of 2 RCTs that compared CBT and standard treatment with standard treatment alone for pain levels was performed. Subjects who received both CBT and standard treatment showed no significant reduction in pain as compared to those who received standard treatment alone after 12 months (standardized mean difference = 0.14, 95% confidence interval = -0.011 to 0.38, $P > 0.05$). In conclusion, the effectiveness of CBT for pain in TMD patients was not shown in the present meta-analysis of RCTs. Additional prospectively controlled and randomized long-term clinical trials are necessary to establish the efficacy of CBT for chronic pain caused by TMD.

**Keywords:** Cognitive-behavioral therapy (CBT), chronic pain, temporomandibular disorder (TMD), randomized control trials (RCTs), meta-analysis

## Introduction

Temporomandibular disorder (TMD) results from problems with the jaw, temporomandibular joint (TMJ), and surrounding facial muscles, with common signs and symptoms of restricted mouth opening, TMJ sounds, and muscle and TMJ pain. Formerly, TMD was thought to occur as a result of malocclusion [1], though more recently several different causes, such as parafunction (bruxism, teeth clenching), trauma, anatomical structures, and psychological factors, have been reported to relate to its development [2-5]. Malocclusion is now considered to be not so significant for TMD, while psychosocial factors have received more attention [6]. Psychological problems (i.e., depression, anxiety) may cause stress to the TMJ and masticatory muscles via activation of the sympathetic nerve system, resulting in increased risk of TMD development and progression [7]. More recent studies have reported the significance of evaluations of psychological disorders and psychosocial dysfunctions that are mainly associated with chronic pain [8-10]. In addition, psychological factors are known to be associated with continuous chronic pain in patients with myofascial pain-dysfunction syndrome caused by hyper-activation of muscle tissue [11]. Thus, psychological aspects are important factors for

understanding the etiology of TMD, and improvements in both musculoskeletal and psychological disorders may be an effective therapeutic goal.

The Research Diagnostic criteria for Temporomandibular Disorders (RDC/TMD), published in 1992, have been widely employed as reliable diagnosis of TMD [12]. These criteria are based on a biopsychosocial model of pain, including both physical (axis I) and psychological (axis II) assessments. However, newer evidence-based diagnostic criteria for temporomandibular disorders were recently published, and recommended for both clinical and research settings [13], as they allow for diagnosis of axis II TMD patients with a range of simple to complex TMD symptoms, as well as evaluations of pain behavior, psychological status, and psychosocial functioning.

Pain is one of the most common and frequent symptoms reported by TMD patients, and standard approaches, including occlusal appliances, physical therapy (i.e., exercise, mobilization), and pharmacologic therapy, have been utilized to gain significant improvements in TMD-related pain in a number of cases [14]. On the other hand, bio-behavioral treatments such as electromyographic biofeedback [15], hypnosis [16], cognitive-behavioral therapy (CBT) [17, 18], relaxation training, and stress management [19] are thought to be useful for management of chronic pain in TMD patients. However, those treatments are often combined, making it difficult to determine which was the most effective for reducing pain in individual cases. Among available bio-behavioral treatments, CBT was previously demonstrated to be the predominant psychological treatment for individuals with chronic pain conditions and is also thought to be effective for reducing pain in TMD patients [17, 18]. In the present study, we performed a meta-analysis of randomized control trails (RCTs) that were conducted to examine the effects of CBT in TMD patients with chronic pain. Our objective was to clarify the usefulness of CBT for TMD and provide updated relevant information.

## Materials and methods

### *Search strategy*

The following criteria for inclusion of trials in this review were used.

1. All reviewed studies were restricted to RCTs that aimed to test the effects of CBT in patients with TMD. 2. All RCT participants were untreated patients diagnosed according to RDC/TMD as axis I or axis II TMD based on clinical examination findings, and who displayed symptoms of TMD caused by psychophysiological problems or bruxism. 3. Outcome measures utilized included subjective assessments of pain by use of a visual analogue scale (VAS) and other accepted methods.

In addition, the following exclusion criteria were employed.

1. Subject age less than 18 years. 2. The focus of the RCT was on jaw deformity/orthodontic therapy-related TMD. 3. Research was performed on subjects with another type of temporomandibular joint disease that must be distinguished from TMD according to the clinical guidelines of the Japanese Society for the Temporomandibular Joint (i.e., congenital or growth abnormality, trauma, inflammation, neoplasm and allied diseases, ankylosis of the temporomandibular joint, masticatory muscle diseases or disorders, temporomandibular joint and/or masticatory muscle diseases or disorders caused by systemic diseases). 4. Observation period longer than 1 year.

The "PubMed" search engine of the National Institutes of Health was employed to search for studies published in English up to March 10, 2016. The search criteria keywords were entered as follows: "Craniomandibular Disorders" [mh] OR "Temporomandibular Joint Disorders" [mh] OR "Temporomandibular Joint Dysfunction Syndrome" [mh] OR "Myofascial Pain Syndromes" [mh] OR "Temporomandibular Joint Disk" [tw] OR "Craniomandibular Disorders" [tw] OR "Temporomandibular Joint Disorders" [tw] OR "Temporomandibular Joint Dysfunction Syndrome" [tw] OR "Myofascial Pain Syndromes" [tw] OR "Pain dysfunction syndrome" [tw] OR "TMJ" [tw] OR "TMD" [tw] OR "CMD" [tw] OR "Temporomandibular Joint Disks" [tw] OR "Myofascial Pain Syndrome" [tw] OR "Temporomandibular Disorders" [tw] OR "Temporomandibular Joint Disease" [tw] OR "craniomandibular-pain" [tw] OR "Meta-Analysis" [pt] OR "Practice Guideline" [pt] OR "randomized controlled trial" [pt] OR "controlled clinical trial" [pt] OR "random allocation" [mh] OR "double-blind method" [mh] OR "single-blind method" [mh] OR "clinical trial [pt]" OR "clinical trial" [tw] AND

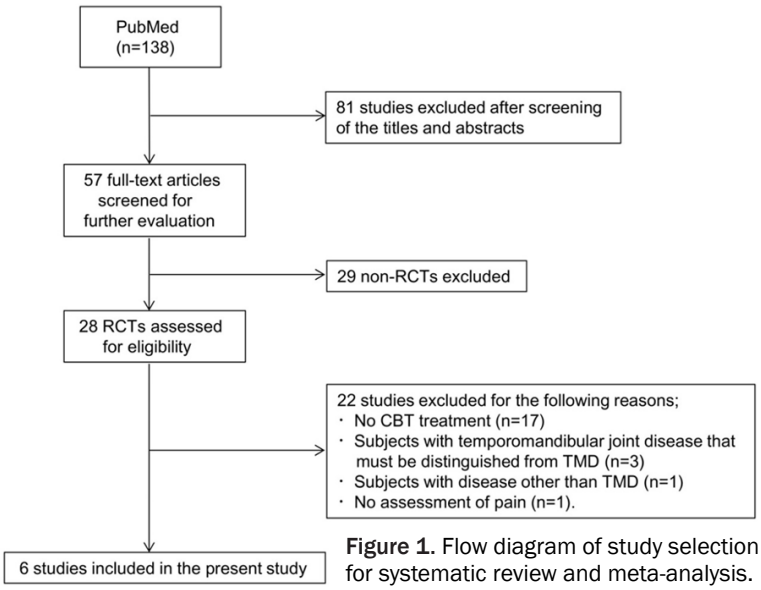


**Figure 1.** Flow diagram of study selection for systematic review and meta-analysis.

"English" [lang] AND "psychophysiologic disorders" [MeSH Terms] OR "psychophysiologic" [All Fields] AND "disorders" [All Fields] OR "psychophysiologic disorders" [All Fields] OR "psychosomatic" [All Fields] AND "disorder" [All Fields] OR "psychosomatic disorder" [All Fields] OR "psychophysiological" [All Fields] AND "Stress" [Journal] OR "stress" [All Fields] OR "mental disorders" [MeSH Terms] OR "mental" [All Fields] AND "disorders" [All Fields] OR "mental disorders"[All Fields] OR "psychiatric" [All Fields] AND "disorder" [All Fields]) OR "psychiatric disorder" [All Fields]) OR "depressive disorder" [MeSH Terms] OR "depressive" [All Fields] AND "disorder" [All Fields] OR "depressive disorder" [All Fields] OR "depression" [All Fields] OR "depression" [MeSH Terms] OR "anxiety disorders" [MeSH Terms] OR "anxiety" [All Fields] AND "disorders" [All Fields] OR "anxiety disorders" [All Fields] OR "anxiety" [All Fields] AND "disorder" [All Fields] OR "anxiety disorder" [All Fields] OR "mood disorders" [MeSH Terms] OR "mood" [All Fields] AND "disorders" [All Fields] OR "mood disorders" [All Fields] OR "mood" [All Fields] AND "disorder" [All Fields] OR "mood disorder" [All Fields]. There was no restriction in regard to publication date. After reviewing the titles and abstracts for relevance, we selected eligible articles according to the inclusion criteria. Titles and abstracts were initially screened to find possible eligible studies. Any uncertainty regarding eligibility was discussed among the authors and the decision regarding whether to include it was made on a consensus basis. The full texts of these studies were further screened by all of the authors to judge if any of the inclusion criteria were matched. Next, we recorded the following information: name of the first author, ethnicity of subjects, year of research, follow-up duration, characteristics of target group, number in target group, numbers of males and females, type(s) of treatment, age of subjects, remarkable efficiency, outline of treatment(s), and background factors. The Cochrane Risk of Bias tool was used to examine the risk of bias in each RCT [20]. Categories of quality assessment were as follows: random sequence generation, allocation concealment, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other sources of bias.

*Statistical analysis*

We performed meta-analysis when we found more than 2 studies with binary pain outcomes, i.e., TMD-related pain outcome that was considered for binary count data regarding a clinically significant decrease in pain or serial pain scores (pain assessed with serial pain scoring such as a VAS). Continuous data for average pain intensity were used for analysis, with the results shown as standardized mean difference (SMD) and 95% confidence interval (CI). All data were analyzed using Excel 2010 (Microsoft Cooperation, Redmond, Washington) and the results were considered statistically significant at $P < 0.05$.

## Results

Our initial search revealed 138 records, of which 81 were subsequently excluded after evaluation of the titles and abstracts (**Figure 1**). Most of those were excluded for focus on other than treatment and research regarding TMD. The full contents of 57 potentially eligible publications were further screened according to the inclusion criteria and divided into 2 groups, RCTs (n = 28) and research papers (n = 29). We then applied the exclusion criteria to those 28 RCTs, which resulted in 6 studies being finally includ-

**Table 1.** Characteristics of the studies included in the review

| Author (year) | Study design | Study location | Ethnicity | Number of patients in experimental group | Age of experimental group (mean) | Number of patients in control group | Age of control group (mean) | Protocol of experimental group | Number of session | Protocol of control group |
|---|---|---|---|---|---|---|---|---|---|---|
| Turner et al. [21] (2005) | RCT | University of Washington, Seattle, Washington, USA | Unclear | 61 | 39.3 | 65 | 35.4 | Cognitive-behavioral pain management training | 4 sessions over 8 weeks | Self-care management |
| Turner et al. [22] (2006) | RCT | University of Washington, Seattle, Washington, USA | Unclear | 72 | 38.9 | 76 | 35.4 | Cognitive-behavioral pain management training | 4 sessions over 8 weeks | Self-care management |
| Gatchel et al. [23] (2006) | RCT | University of Texas, Texas, USA. | Caucasian, Hispanic, African-American, Asian | 56 | 36.7 | 45 | 39.1 | Early intervention including CBT and biofeedback | 6 sessions | Nonintervention |
| Dworkin et al. [19] (2002) | RCT | University of Washington, Seattle, Washington, USA | Unclear | 61 | 37.4 | 63 | 38 | Self-care intervention incorporating CBT | CBT intervention on 3 different occasions: the first session (75 minutes) was followed by a second session (50-60 minutes) 2 weeks later, then the final session was performed 1 month after the second session. | Usual treatment (i.e., physiotherapy, education, medications and use of intraoral flat plane occlusal appliances) |
| Dworkin et al. [17] (1994) | RCT | University of Washington, Seattle, Washington, USA | Unclear | 66 | 38.4 | 73 | 35.9 | CBT in combination with usual treatment | 2-hours sessions twice | Usual treatment |
| Dworkin et al. [18] (2002) | RCT | University of Washington, Seattle, Washington, USA | Unclear | 59 | 38.6 | 58 | 39.3 | CBT in combination with usual treatment | 6 sessions | Usual treatment |

| Author (year) | Method of pain assessment | Outcome measure | Follow-up period | Random sequence generation | Blinding of outcome assessment | Allocation concealment | Incomplete outcome data | Selective outcome reporting | Other sources of bias |
|---|---|---|---|---|---|---|---|---|---|
| Turner et al. [21] (2005) | Grand chronic pain scale, characteristic pain intensity, coping strategies questionnaire , survey of pain attitudes, pain catastrophizing scale | TMD pain intensity, pain-related activity interference, jaw limitation, pain coping | 8 weeks | LR | UR | UR | LR | LR | UR |
| Turner et al. [22] (2006) | Grand chronic pain scale, survey of pain attitudes , pain catastrophizing scale , coping strategies questionnaire catastrophizing scale | TMD pain intensity, jaw use limitation, depression, pain coping, treatment credibility, TMD knowledge, treatment helpfulness | 12 months | LR | UR | LR | LR | LR | UR |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gatchel et al. [23] (2006) | Characteristic pain intensity, self-reported pain intensity scale | TMD pain intensity, depression, ways of coping | 12 months | UR | UR | UR | LR | LR | UR |
| Dworkin et al. [19] (2002) | Characteristic pain intensity, graded chronic pain score | TMD pain intensity, pain-related activity interference, vertical jaw range of motion, number of painful extraoral muscle palpation site | 12 months | UR | UR | UR | LR | LR | UR |
| Dworkin et al. [17] (1994) | Visual analog scales , graded chronic pain score | TMD pain intensity, pain interference with daily activity, jaw range of motion | 12 months | LR | UR | UR | LR | LR | UR |
| Dworkin et al. [18] (2002) | Characteristic pain intensity, graded chronic pain score | Pain-related activity interference, vertical jaw range of motion, number of painful palpation site | 12 months | UR | UR | UR | LR | LR | UR |

RCT, randomized control trial. The risk of bias was classified as low risk (LR), high risk (HR) or unclear risk (UR).

ed in the present study (**Table 1**). The reasons for exclusion were no CBT treatment (n = 17), subjects with temporomandibular joint disease that must be distinguished from TMD (n = 3), subjects with disease other than TMD (n = 1), and no assessment of pain (n = 1).

Next, we categorized those 6 studies into 4 subgroups according to the clinical treatments reported; CBT versus stress management, CBT plus biofeedback versus nonintervention, CBT versus standard treatment alone, and CBT plus standard treatment versus standard treatment alone. We were unable to perform meta-analysis of the 6 RCTs because of different CBT protocols and follow-up periods utilized in each of those studies. However, meta-analysis using 2 of the RCTs (CBT plus standard treatment vs. standard treatment alone) was performed to examine the efficacy of CBT towards pain.

*CBT versus stress management*

Turner et al. performed 2 RCTs to examine the effects of cognitive-behavioral pain management training as compared to stress management, using binary pain outcomes [21, 22]. In the first study, they found that subjects who received cognitive-behavioral training (4 sessions over 8 weeks) did not differ significantly in regard to pain intensity after 1 and 8 weeks as compared to those who used self-care management [21]. On the other hand, the second study evaluated the effectiveness of brief CBT at 3, 6, and 12 months after the last treatment, which revealed that subjects who underwent CBT had significantly attenuated pain intensity as compared to the control subjects after 12 months [22]. These results suggested that CBT has a capability to improve long-term clinical outcomes as compared to stress management. Nevertheless, these RCTs had different observation periods, thus we could not combine the data for performance of meta-analysis.

*Early intervention including CBT and biofeedback versus nonintervention*

Gatchel et al. examined the effects of early intervention including CBT and biofeedback as compared to nonintervention in patients with TMD-related pain [23], in which a modified version of a CBT program was used for TMD patients with depression. Their characteristic protocol topics were education regarding the mind-body relationship, with an emphasis on stress and the body's reaction to stress, relaxation training in ideal and everyday settings, use of distraction and pleasant activity scheduling as a means of reducing the impact of pain on activities, cognitive restructuring, self-instructional training, and maintenance of skills. They performed 1-hour CBT sessions of a total of 6 times. Their results showed that the combination of CBT and biofeedback more significantly reduced chronic pain levels and emotional distress as compared to nonintervention at 1-year follow-up examinations. Furthermore, subjects in the nonintervention group showed a higher rate of mental problems, such as somatoform disorder, anxiety, and affective disorder, as compared to those in the early intervention group. However, it remains unknown whether CBT alone can improve pain and psychological disorders.

*Self-care intervention incorporating CBT versus usual treatment alone*

Dworkin et al. investigated the effects of self-care intervention incorporating CBT for patients with minimal levels of psychological disorders [19]. Their usual treatment protocol included physiotherapy, education, medications, and use of an intraoral flat plane occlusal appliance. Subjects in the self-care group received CBT intervention on 3 different occasions, in which the first session (75 minutes) was followed by a second session (50-60 minutes) 2 weeks later, then the final session was performed 1 month after the second session. The major components of the self-care group were education about the biophysical model of TMD, guided reading with structured feedback, relaxation and stress management training for self-monitoring of signs and symptoms, development of a "Personal TMD Self-Care Plan", supervised practice and reinforcement of dentist prescribed self-care treatments and maintenance, and relapse prevention. The self-care intervention group exhibited greater decreases in pain level and pain-related disability as compared to subjects who received usual treatment alone at follow-up examinations performed after 12 months. Their results suggest that a well-organized self-care plan may be helpful for reducing pain in TMD patients with mild psychological disorders.

*CBT in combination with usual treatment versus usual treatment alone*

Dworkin et al. examined the usefulness of brief CBT, which was given as a 2-hour session twice,

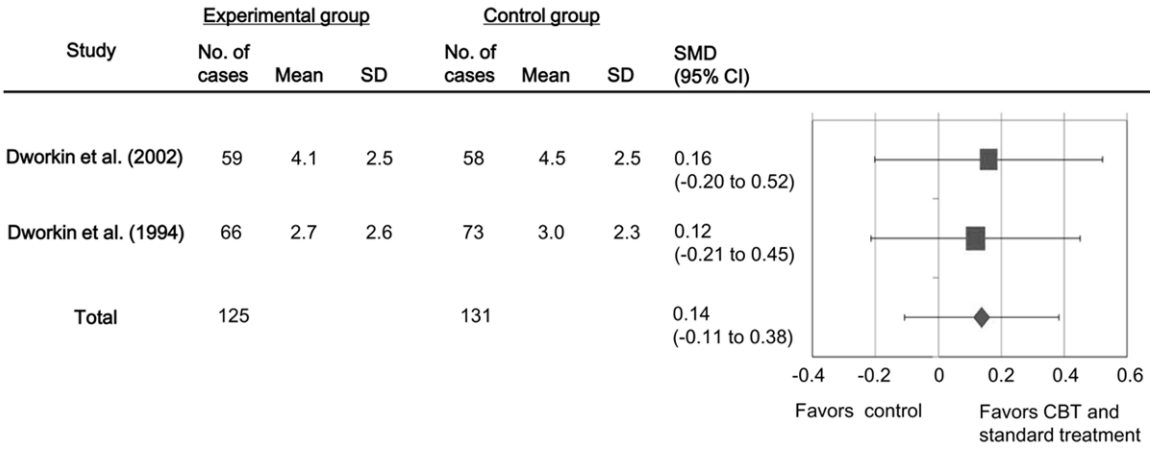


**Figure 2.** Meta-analysis of 2 RCTs performed to compare pain levels between CBT in combination with usual treatment and usual treatment alone. Subjects who received both CBT and usual treatment exhibited no statistically significant reduction in pain as compared to those who received usual treatment alone at follow-up examinations performed at 12 months (SMD = 0.14, 95% CI = -0.11 to 0.38, $P > 0.05$).

at 3- and 12-month follow-up examinations [17]. Psychologists and dentists trained using a detailed therapist's manual performed CBT for their TMD patients. After 12 months, they found that subjects who received brief CBT sessions spaced 1 week apart prior to receiving usual treatment exhibited a greater rate of decrease in pain level as compared to those who received standard treatment alone. However, subjects who were classified as having a high level psychological disorder did not show a favorable response to their brief CBT protocol.

The same group also performed 6 intensive CBT sessions (engagement, main program, maintenance) in combination with usual treatment in psychosocially disabled TMD patients [RDC/TMD axis II grade scale of chronic pain (GCP) score of II, III, or IV] [18]. The main program included behavior/relaxation, cognitive coping, explanatory model, health care, and personal planning. They found that pain intensity was decreased in subjects who received CBT in combination with usual treatment as compared to those who received usual treatment alone at the post-treatment evaluations performed approximately 4 months later, as well as 6 and 12 months after therapy. At the post-treatment time point, pain intensity was significantly lower in the CBT in combination with usual treatment group. However, subjects who received CBT in combination with usual treatment for only 6 sessions did not exhibit an initial marked rate of decrease in TMD-related pain as compared to those who received usual treatment alone. Furthermore, there was no statistical difference in pain intensity after 6 months and 1 year between the groups. These results suggest that psychosocially disabled patients exposed to pre-CBT treatment show an initial positive response, but do not consistently recover from pain in the absence of CBT treatment.

We performed meta-analysis of these 2 RCTs to examine the effect of CBT on pain level. Subjects who received both CBT and usual treatment did not show significantly reduced levels of pain as compared to those who received standard treatment alone at the 12-month observation period (SMD = 0.14, 95% CI = -0.11 to 0.38, $P > 0.05$) (**Figure 2**). Publication bias could not be assessed because of the inadequate number of included trials.

## Discussion

A previous report divided chronic pain into nociceptive (i.e., musculoskeletal pain), neuropathic, and psychogenic [24]. They noted that nociceptive pain is caused by continuous or repetitive stimuli on pain receptors, which recognize and react to a stimulus, and send pain signals through the nervous system, neuropathic pain is related to nervous system disorders, resulting in pain messages being sent to the central nervous system regardless of local stimuli, and importantly, psychogenic pain is connected to psychological factors that can cause orofacial chronic pain. Since not only

musculoskeletal disorders but also psychosocial problems may be associated with establishment of chronic pain in TMD patients, psychosocial approaches have become vital for their treatment. For TMD patients with chronic pain, psychosomatic treatments (stress management, bio-feedback, relaxation, CBT) have become widespread and commonly performed [15, 17-19], while evidence for the effectiveness of psychological therapy for management of chronic pain has been presented in a variety of studies [14-19]. Among available psychological treatments, CBT is a common practical and short-term form of psychotherapy, which has been proven valid for treating psychological disorders in patients with axis II pain-related disability [17]. Basically, CBT includes techniques to help patients recognize elements that affect pain and change their maladaptive thinking, and then learn how to control their pain and encourage continuous improvement in their condition [17]. CBT is thought to be prevalent along with other physiologic therapeutic methods for relieving physiological factors such as anxiety and stress.

Despite the effectiveness of CBT for chronic pain, such as back pain, headaches, and orofacial pain [25, 26], it is difficult to clarify its validity for chronic pain in TMD patients. One reason for this is lack of a standard CBT protocol for chronic pain treatment for individuals or groups. When used for coping with chronic pain, the protocol often includes relaxation skill training, behavioral activation, cognitive restrictions, and exercises [27]. However, many studies of CBT for TMD patients have shown considerable differences in contents, including specific techniques, background of the CBT provider, frequency of sessions, duration of treatment, and observation period after therapy [17-19, 21, 22]. Furthermore, some studies investigated the effectiveness of CBT alone as treatment for TMD-related pain, while others performed CBT in combination with another bio-behavioral therapy [17-19, 21, 22]. Therefore, evaluation of the effectiveness of CBT itself as treatment for chronic pain related to TMD is complicated.

Among research performed to investigate the validity of CBT alone, Mishra et al. reported that CBT resulted in greater levels of decreased pain in patients with chronic TMD as compared to no treatment [28]. That CBT protocol included modified CBT treatment for depression and another pain management program, and their study was conducted according to standardized research diagnostic criteria developed by another group [12]. Interestingly, biofeedback was found to be the most effective for reducing pain perception as compared to other treatment protocols investigated, including CBT alone, combined CBT/biofeedback, and no treatment. To explain their findings, the authors noted that the patients might have been more receptive to physical therapy (i.e., biofeedback) than psychosocial treatment (i.e., CBT), because they generally tended to recognize TMD as a physical disorder. On the other hand, Gardea et al. also reported that CBT resulted in greater levels of decreased pain in TMD patients as compared to no treatment, though the combination of CBT and biofeedback was the most effective for reducing pain, pain-related disability, and interference with facial activity [29]. Thus, CBT in combination with other bio-behavioral treatments may be more effective than CBT alone to reduce pain in TMD patients.

One of the RCTs did not clearly demonstrate the effectiveness of CBT. Dworkin et al. reported that combined intervention with 6 sessions of CBT and usual TMD treatment did not significantly improve TMD-related pain as compared to subjects who received usual treatment alone [18]. It has been speculated that psychosocially disabled individuals do not consistently recover from pain when the CBT sessions are few. Mishra et al. performed CBT much more frequently (12 sessions) for patients without any psychosis and noted the validity of CBT for reducing pain level [28]. Thus, an appropriate number of CBT sessions may be essential for decreasing pain, especially in TMD patients with psychosocial disorders.

Tuner et al. reported that CBT significantly improved pain intensity as compared to the control group at 12-month follow-up examinations, but not at such examinations conducted at 8 weeks, suggesting that a longer follow-up period is necessary to evaluate effectiveness [21, 22]. Their results indicate that the duration of follow-up time after CBT is a key factor to accurately assess change in chronic pain level and we consider that at least 1 year may be essential.

Effective treatment of psychogenic pain disorders may be impossible without an integrative and interdisciplinary approach conducted by specialists trained in psychological therapy. Certainly, the competence of the CBT provider can affect the results of therapy for TMD patients. However, the association between provider ability and outcome has not been fully elucidated. In addition to clinical psychologists, clinicians (dentists, advanced doctoral students) trained in pain management have conducted CBT in previous studies [17, 28]. One study found that therapist competence was associated with the effectiveness of CBT for individuals with depression, indicating that the treatment provider background and level of skill may be significant factors related to prognosis [30]. Taken together, the psychological condition of the patient, treatment contents, frequency of sessions, and capability of the treatment provider should all be considered in order to obtain effective CBT results.

The Diagnostic and Statistical Manual of Mental Disorders (DMS) published by the American Psychiatric Association (APA) has been recommended for performing psychological diagnosis, and the revised 5th edition was recently published [31]. This manual may be helpful for diagnosis of TMD axis II patients and performing a psychosocial approach. However, criteria for diagnosis of axis II have not been well accepted in Japan and there are no long-term clinical studies of the effects of bio-behavioral treatments provided for TMD patients. Thus, bio-behavioral treatment is not commonly used for TMD in Japan. As a first step, it is important to recognize the significance of a diagnosis of axis II and the value of psychosomatic medication for chronic pain in a clinical setting. Furthermore, the DMS should be referred to by trained clinicians such as psychiatrists for appropriate axis II diagnosis in TMD patients. Also, clinical cooperation between the attending dentist and specialists in psychosomatic medicine may be required for sufficient management of bio-behavioral treatment performed with CBT.

In conclusion, we were unable to clarify the efficacy of CBT in this meta-analysis of RCTs because of the different protocols and follow-up periods utilized. Additional prospective, controlled, randomized, long-term clinical trials are needed to establish the effectiveness of CBT for chronic pain in TMD patients.

## Disclosure of conflict of interest

None.

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