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Association of Oral Behaviors with Anxiety, Depression, and Jaw Function in Patients with Temporomandibular Disorders in China: A Cross-Sectional Study

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Background: The aim of this study was to investigate the association of oral behaviors (OBs) with anxiety, depression, and jaw function in patients with temporomandibular disorders (TMDs) in China.

Material/Methods: A total of 537 patients diagnosed with TMD were included in this study (average age, 31.55±12.08 years; 86 men [16.0%] and 451 women [84.0%]). There were 31 cases of masticatory muscle pain, 459 cases of disc displacement, and 13 cases of arthralgia/arthritis, and 34 cases were uncategorized. Patients were assessed using the Oral Behaviors Checklist (OBC), Jaw Functional Limitation Scale (JFLS), Generalized Anxiety Disorder-7 (GAD-7) scale, and Patient Health Questionnaire-9 (PHQ-9). The relationships between OBC scores and mouth opening, pain scores, JFLS, PHQ-9, and GAD-7 were evaluated with Spearman's correlation analysis. The median TMD symptom duration was 3 (0.5-154) months; men and women did not differ significantly in symptom duration or in the number of episodes of depression and anxiety.

Results: The following OBs were common in patients with TMDs: "putting pressure on the jaw (52.9%)", "chewing food on 1 side (47.5%)", and "holding teeth together during activities other than eating (33.3%)". The OBC scores were significantly correlated with the JFLS, PHQ-9, and GAD-7 scores ($P<0.01$).

Conclusions: Patients with TMDs exhibit specific OBs, which are associated with depression, anxiety, and jaw function. It is necessary to further investigate the interaction of OBs with depression and anxiety in the development of TMDs.

Keywords: **Anxiety • Depression • Jaw Abnormalities • Temporomandibular Joint Disorders**

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Background

Temporomandibular disorders (TMDs) are a group of diseases with complex pathogenic factors, including malocclusion, craniofacial trauma, neurological and psychological factors, and oral behaviors (OBs) [1]. OBs, or oral parafunctions, mainly refer to activities other than normal oral physiological functions. They include activities such as chewing gum, clenching teeth, biting nails, and leaning the jaw on the hand, which may lead to TMDs. Studies in some disease models with OBs as causative factors of TMDs indicate that OBs can affect the masticatory musculature, resulting in tissue injury around the temporomandibular joint, pain, and functional limitations [2]. Additionally, OBs can cause stomatognathic microtrauma, particularly in the temporomandibular joint. Leketas et al found that OBs, such as clenching teeth, bruxism, tensing of the muscles, and sustained talking, are associated with TMDs [3].

However, it has been reported that OBs, or oral parafunctions, are not only risk factors for, but also are consequences of TMDs. Some bio-behavioral studies [4,5] have pointed out that psychosocial factors such as stress, depression, and anxiety play an important role in the occurrence and development of TMDs. Psychological stress in the form of anxiety and depression can increase OBs such as bruxism [6] and teeth clenching. A previous analysis [7] revealed that the incidence of oral parafunctions increased in individuals with depressive symptoms, possibly due to their fear-avoidance behavior. Therefore, OBs can be a sign of psychological stress and should not be regarded simply as a cause of disease.

Studies have focused mainly on specific OBs such as nail or lip biting, unilateral masticatory habit, and playing musical instruments that require certain mouth and chin positions, but the frequencies and characteristics of different OBs were not described in detail. This makes it difficult to compare the data between different studies. The Oral Behaviors Checklist (OBC) [8] comprises 21 items that evaluate the presence and frequency of OBs during night and day times, and semi-quantitative scoring was performed according to the frequency of OBs. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) [9] recommends the use of OBC to screen patients for OBs and states that this checklist can be used for the complete study of OB characteristics in patients with TMDs.

To date, the OB characteristics of patients with TMDs have mostly been ignored, and only a few studies have assessed the relationships of OBs with depression, anxiety, and limited jaw function in Chinese patients. The Orofacial Pain Prospective Evaluation and Risk Assessment (OPPERA) study [1] showed that the characteristics of TMD-related symptoms have no significant differences between male and female patients with TMDs, but only a few studies have compared the differences

of OBs between the sexes. This cross-sectional study aimed to examine the OB characteristics of patients with TMDs in China and further evaluate their correlation with jaw function, pain, mouth opening, depression, and anxiety.

Material and Methods

Study Setting and Participants

This cross-sectional study included 537 consecutive patients with TMDs who visited the Ninth People's Hospital between July 2017 and May 2018. The study was approved by the Ethics Committee of the Ninth People's Hospital (No. 2016-114-T63; Clinical Trials Registration Number: ChiCTR-INTR-16009881). The study procedures were in compliance with the Declaration of Helsinki. All participants provided informed consent to participate in the study.

Inclusion criteria were a diagnosis of TMD in accordance with DC/TMD [9], and completion of the assessments consisting of the OBC, Jaw Functional Limitation Scale (JFLS), Patient Health Questionnaire-9 (PHQ-9), and Generalized Anxiety Disorder-7 (GAD-7) scale. Exclusion criteria included a history of face or head trauma; facial or cranial fractures in the previous 10 years; rheumatoid arthritis, psoriatic arthritis, gout, or other systemic diseases that can affect the masticatory system; and oncologic or inflammatory diseases of the face or jaw.

Measurements

The Chinese version of the OBC, a self-reported questionnaire used to identify and quantify the frequency of different OBs, was obtained from www.rdc-tmdinternational.org. The OBC has 21 questions related to OBs, with each having 5 possible answers: none of the time=0; a little of the time=1; some of the time=2; most of the time=3; and all of the time=4. For the first 2 questions, which are about OBs that occur at night, the possible answers are: none of the time=0; <1 night per month=1; 1 to 3 nights per month=2; 1 to 3 nights per week=3; and 4 to 7 nights per week=4.

Jaw function was assessed using the JFLS [10], and the GAD-7 [11] and PHQ-9 [12] were used to evaluate anxious and depressive moods, respectively, in patients with TMDs [9]. The total GAD-7 score ranges from 0 to 21, and the total PHQ-9 score ranges from 0 to 27. Anxiety and depression in patients were defined as a GAD-7 score ≥ 10 and a PHQ-9 score ≥ 10 , respectively. Patients completed these questionnaires during the first treatment session. All patient queries regarding the questionnaires were resolved by the assessor to ensure that patients completely understood the questions.

The examinations of all enrolled patients were completed by investigators who had more than 5 years of experience in diagnosing patients with TMDs. The investigators asked specific questions pertaining to the patients' pain and examined mouth opening and closing, range of motion of the jaw, and the position of pain. The maximum painless mouth opening (in mm) was measured, and the pain was assessed by a numeric rating scale ranging from 0 to 10.

Statistical Analysis

Statistical analyses were performed using SPSS, version 23 (IBM Corp., Armonk, NY, USA). The frequencies of specific OBs were analyzed based on the total number of subjects with those OBs. Descriptive statistics were presented as mean±standard deviation. To measure internal consistency, Cronbach's alpha (α) of the Chinese version of the OBC was used, with $\alpha > 0.7$ indicating good reliability. The rank-sum test was used to show the sex distribution of individual OBs in patients with TMDs. The correlations between GAD-7, PHQ-9, jaw function, pain score, mouth opening, and OBC score were analyzed by Spearman's correlation. Because 5 comparisons were made, statistical significance for 2-sided statistical testing was set at $\alpha = 0.05/5 = 0.01$.

Results

This study included 537 patients with TMDs (average age, 31.55 ± 12.08 years; range, 15-68 years; 86 men [16.0%] and 451 women [84.0%]). The median TMD symptom duration was 3 (0.5-154) months; the symptom duration and the number of episodes of anxiety and depression did not differ significantly between men and women. Details of the patients' diagnostic classification are shown in **Table 1**. The internal consistency of OBC scores was $\alpha = 0.771$ for the entire study sample. The total OBC score was calculated and categorized as follows [13]: 0 to 16 (29.0%), 17 to 24 (27.7%), and ≥ 25 (43.2%) (**Table 1**).

To determine the most common OBs, the scores were dichotomized. If the patient chose "most of the time" or "all of the time" for a specific item, it was considered that the patient had that OB (**Table 2**). More than half of the patients with TMDs reported that they were sleeping in a position that could exert pressure on the jaw (52.9%). Moreover, "chewing food unilaterally", "clenching, touching, or holding the teeth together during activities other than eating", "yawning", and "eating between meals" were very common behaviors in patients with TMD. The total OBC scores differed significantly between men and women ($P < 0.05$). However, most OBs were comparable between men and women, except for "lean with your jaw on your hand", "yawning", "eating between meals", and "chewing food on 1 side".

Depression and anxiety symptoms were observed in 14.5% and 10.2% of patients with TMDs, respectively (**Table 1**). Generally, the total OBC score correlated significantly with the JFLS, PHQ-9, and GAD-7 scores ($P < 0.01$; **Table 3**).

Discussion

This study showed that patients with TMDs do have certain OBs, such as "pressing, touching, or holding the teeth together during activities other than eating", "chewing food on 1 side", and "putting pressure on the jaw". These results were basically consistent with those of Leketas et al [3]. Certain OBs such as "grinding teeth while awake", "tightening or tensing muscles", and "talking for a long time" could increase the risk of TMDs [14]. However, most previous studies have examined only a small number of OBs, such as chewing gum, bruxism, and thumb-sucking [15,16]. The use of the OBC in this study allowed the evaluation of a wider spectrum of OBs.

The OBC uses scores of 0 to 4, graded according to the frequency of the OBs, which allows semi-quantitative analysis. A score of 3 or 4 indicated that the patient had that particular oral habit. This semi-quantitative scoring helps the patients choose the appropriate answer, and thus reflects OB characteristics more accurately. Recently, different language versions of the OBC [17,18] have been used clinically, with good reliability for OB evaluation. The Chinese version of the OBC used in this study also had good reliability (Cronbach's $\alpha = 0.771$).

Different OBs can increase the load of the temporomandibular joint and cause some pathological changes in the joint and its surrounding tissues. Pressure in the temporomandibular joint cavity is the highest in the maximal intercuspal position [19], and the pressure on the side of the articular disc increases [20] when the teeth are clenched [21], which can lead to articular disc injury. Masumeh et al [22] reported that eating hard food is more likely to induce unilateral chewing than is eating soft food, as the bite force may differ between sides. When chewing hard food, patients tend to use the dominant side. A cone-beam computed tomography-based study [23] found that individuals with unilateral chewing function, compared with individuals without this function, had the following manifestations on the chewing side: (1) narrower posterosuperior, posterior, and lateral joint spaces; (2) shorter condylar neck; and (3) smaller inclination of the articular eminence. The increase of excessive stress in articular cartilage can lead to the increase of degradation of type II collagen and proliferation of type III collagen [24], which may be related to the pathogenesis of TMD. In this study, "chewing food on 1 side" (47.5%), "pressing, touching, or holding the teeth together during activities other than eating (33.3%)" and "clenching or grinding teeth when asleep (22.5%)" habits theoretically increased

Table 1. Duration of symptoms, depression, anxiety, oral behaviors, jaw function, mouth opening, pain, and social status in male and female patients with temporomandibular disorders.

	Female n=451	Male n=86	Total n=537	P value
	n (% of Females)	n (% of Males)	n (% of Total)	
Residence				0.409
Rural	355 (78.7)	63 (73.3)	418 (77.8)	
Urban	96 (21.3)	23 (26.7)	119 (22.2)	
Marriage status				0.527
Unmarried	213 (47.2)	49 (60.0)	262 (51.8)	
Married	225 (49.9)	34 (39.5)	259 (48.2)	
Divorced, Widowed	13 (2.9)	3 (3.5)	16 (3.0)	
Ethnic group				0.488
Han nationality	436 (96.7)	84 (97.7)	520 (96.8)	
Minority nationality	15 (3.3)	2 (2.3)	17 (3.2)	
Education status				0.269
High school	119 (26.4)	22 (25.6)	141 (26.3)	
College degree	269 (59.6)	52 (60.5)	321 (59.8)	
Postgraduate degree	63 (14.0)	12 (13.9)	75 (13.9)	
Duration of symptoms				0.996
<1 month	45 (9.9)	11 (12.8)	56 (10.4)	
1-3 months	212 (47.0)	40 (46.5)	252 (47.0)	
4-6 months	89 (19.7)	18 (20.9)	107 (19.9)	
>6 months	105 (23.3)	17 (19.8)	122 (22.7)	
Diagnose subgroup				
Masticatory muscle pain	27 (6.0)	4 (4.7)	31 (5.8)	
Disc displacement	387 (85.8)	72 (83.7)	459 (85.5)	
Arthralgia	9 (2.0)	4 (4.7)	13 (2.4)	
Uncategorized	28 (6.2)	6 (6.9)	34 (6.3)	
PHQ-9				0.826
≥10	65 (14.4)	13 (15.1)	78 (14.5)	
GAD-7				0.788
≥10	47 (10.4)	8 (9.3)	55 (10.2)	
OBC score				0.012
0-16	125 (27.7)	31 (36.4)	156 (29.0)	
17-24	121 (26.8)	28 (32.6)	149 (27.7)	
≥25	205 (45.5)	27 (31.4)	232 (43.2)	
	Mean±SD	Mean±SD	Mean±SD	
JFLS	45.0±27.3	36.9±28.3	43.8±27.6	0.004
MMO (mm)	28.8±8.4	32.2±9.2	29.4±8.7	0.001
Pain score	3.0±2.3	2.2±2.2	2.9±2.3	0.023

GAD-7 – Generalized Anxiety Disorder-7; JFLS – Jaw Functional Limitation Scale; MMO – maximum mouth opening; OBC – Oral Behaviors Checklist; PHQ-9 – Patient Health Questionnaire-9; SD – standard deviation.

Table 2. Prevalence of oral behaviors in male and female patients with temporomandibular disorders.

Oral behaviours	Females (%)	Males (%)	Total (%)
	n=451	n=86	n=537
1 Clench or grind teeth when asleep	107 (23.7)	4 (4.7)	121 (22.5)
2 Sleep in a position that puts pressure on the jaw	246 (54.6)	39 (45.4)	284 (52.9)
3 Grind teeth	3 (0.7)	2 (2.3)	5 (0.9)
4 Clench teeth	31 (6.9)	4 (4.7)	35 (6.5)
5 Press, touch, or hold teeth together other than while eating	157 (34.8)	22 (25.6)	179 (33.3)
6 Hold, tighten, or tense muscles without clenching or bringing teeth together	67 (14.9)	10 (11.6)	77 (14.3)
7 Hold or put jaw forward or to the side	59 (13.1)	6 (7.0)	65 (12.1)
8 Press tongue forcibly against teeth	28 (6.2)	5 (5.8)	33 (6.1)
9 Place tongue between teeth	70 (15.5)	10 (11.6)	80 (14.9)
10 Bite, chew, or play with your tongue, cheeks, or lips	17 (3.8)	2 (2.3)	19 (3.5)
11 Hold jaw in rigid or tense position, such as brace or protect the jaw	47 (10.4)	8 (9.3)	55 (10.2)
12 Bite or hold objects between the teeth	31 (6.9)	7 (8.1)	38 (7.1)
13 Use chewing gum	16 (3.5)	3 (3.5)	19 (3.5)
14 Play musical instruments that involve use of mouth or jaw	4 (0.9)	2 (2.3)	6 (1.1)
15 Lean with your jaw on the hand	108 (23.9)*	15 (17.4)	123 (22.9)
16 Chew food on one side	220 (48.8)*	35 (40.7)	255 (47.5)
17 Eat between meals	174 (38.6)*	21 (24.4)	195 (36.3)
18 Sustained talking	115 (25.5)	19 (22.1)	134 (25.0)
19 Singing	21 (4.7)	2 (2.3)	23 (4.3)
20 Yawning	185 (41.0)*	21 (24.4)	206 (38.4)
21 Hold telephone between your head and shoulders?	16 (3.5)	1 (1.2)	17 (3.2)

* $P < 0.05$ vs men.

Table 3. Spearman correlations among OBC, JFLS, GAD-7 scale, and PHQ-9.

Spearman's coefficient	Pain	JFLS	OBC	PHQ-9	GAD-7
MMO	-0.168**	-0.406**	0.095*	-0.009	-0.010
Pain		0.305**	0.134**	0.316**	0.338**
JFLS			0.209**	0.317**	0.267**
OBC				0.375**	0.322**
PHQ-9					0.753**

** $P < 0.01$. GAD-7 – Generalized Anxiety Disorder-7; JFLS – Jaw Functional Limitation Scale; MMO – maximum mouth opening; PHQ-9 – Patient Health Questionnaire-9; OBC – Oral Behaviors Checklist.

the daily load and mechanical stress on the temporomandibular joint, which may be related to degeneration of the joint.

The male-to-female ratio in this study was approximately 1: 5, and, compared with men, women with TMDs showed less mouth opening, more severe pain, and more limited jaw functions ($P<0.05$), which are features that may be related to a higher sensitivity in women with TMDs. Additionally, because women showed a greater frequency of eating between meals in this study, their TMJ load was higher. One study found that TMD-related symptoms have a greater impact on the quality of life of female patients [4], leading to a higher proportion of women seeking medical care. In the present study, the proportion of OBC scores ≥ 25 in women with TMDs (45.5%) was higher than that in men. The OPPERA study [13] reported that when the OBC score was greater than 25, the corrected odds ratio was 16.8 (95% confidence interval 8.6-32.9), suggesting that OB may be an important risk factor for TMDs; however, its specific impact during different stages of TMD development remains unclear.

Studies have indicated that depression and anxiety may be risk factors for TMD-related pain [25]. Psychological factors such as psychological distress, pain catastrophizing [26], fear-avoidance behaviors [27], depression and anxiety [28], and passive coping strategies [29] are associated with the increased pain and disability levels in patients with painful TMDs. Depression and anxiety have been documented to influence muscular activities [30]. This can disturb the harmonization among the closely matched muscles around the joint and induce changes in their mechanical properties, eventually resulting in muscle pain. This condition can also initiate inflammatory reactions in the joint, eliciting secondary biomechanical changes and joint pain. Simultaneously, patients with TMDs can have abnormal trigeminal pain processes [31], which may be related to an imbalance of 5-hydroxytryptamine and catecholamine neurotransmitters. Therefore, psychological or emotional problems are also involved in the pathogenesis of TMDs, emphasizing the significance of mental state evaluation.

In this study, the total OBC score correlated with depression and anxiety ($r=0.375$ and 0.322 , respectively; $P<0.01$), indicating that OBs may be related to patients' psychological states and involve complex interactions. Patients with depression or anxiety can demonstrate an increase in certain OBs, which may be intended to relieve psychological pressure. Therefore, more studies are needed to confirm the relationship between OBs and patient psychology. However, the results of this study need to be interpreted carefully. We used a convenience sample of patients with TMDs; therefore, the symptoms of these patients might be more severe than those found in the larger population. Many patients with myogenic TMD, whose symptoms ranged from mild to moderate, were treated with oral medications and were not included in the study. Therefore, because 85.5% of patients had disc displacement, there was a certain bias in the study sample, and the overall situation of patients with TMD might not be accurately represented. A healthy control group was not included in the present study; therefore, a comparison between patients and healthy participants was not performed.

Conclusions

The results of this pilot study suggest that there are differences in OBs between men and women with TMDs, which may be related to the severity of symptoms. OBs were associated with depression, anxiety, and limited jaw function. These factors may have complex interactions and change with the development of the disease. Thus, additional cohort studies are warranted to further explore these relationships.

Conflict of Interest

None.

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