

Relationship between Otologic Symptoms, Headache, Depression and Temporomandibular Disorders

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Abstract

Background: The etiology of temporomandibular disorder (TMD) is largely unknown. Some studies have been implicated that otologic symptoms are associated with the predisposition, initiation, and perpetuation of TMD. The aim is to investigate the associations of aural symptoms, headache and depression with the presence of TMD symptoms in young adults.

Methods: A personal interview survey was conducted on first-year university students (n=1,930; 18.6 ± 2.1 years) regarding symptoms of temporomandibular disorders (TMD), aural problems, headache, shoulder pain and depression. Logistic regression was applied to assess the associations of these problems with the presence of TMD symptoms after controlling for age and gender.

Results: Among the 1,930 students, 543 students exhibited TMD symptoms and were classified into 7 groups: clicking only (Group I, n=319), pain in the TMJ only (Group II, n=21), difficulty in mouth opening only (Group III, n=18), clicking and pain (Group IV, n=29), clicking and difficulty in mouth opening (Group V, n=48), difficulty in mouth opening and pain (Group VI, n=11), and combination of three symptoms (Group VII, n=97). The control group (n=1,387) were subjects without any TMD symptoms. After adjusting for age and gender, a strong association was observed between TMD symptoms (Group II and IV) and tinnitus (OR=12.1 and 13.2, respectively). TMD symptoms (Group I, II and III) were also associated with vertigo and headache. Otalgia and depression were significantly associated with the presence of clicking only.

Conclusions: TMD symptoms were significantly correlated to aural symptoms and headache. A functional evaluation of the stomatognathic system should be considered in subjects with unexplained aural symptoms and headache.

Keywords: Headache; Temporomandibular disorders; Tinnitus; Vertigo; Young adults

Introduction

Literature data suggest that temporomandibular disorders (TMDs) recognize a multifactorial aetiology and characterized by various signs and symptoms including pain and dysfunction in the temporomandibular joint (TMJ) and/or the

masticatory musculature. Apart from these sites of pain and dysfunction other areas of the face and neck can be involved, e.g. the temporal, occipital, and frontal areas of the head, and auricular area [1,2]. In addition, a stronger severity of TMD and higher depression levels were also linked with the presence of autologic symptoms [3].

Otologic Symptoms

Otologic symptoms have been implicated in the predisposition, initiation, and perpetuation of TMD but with little scientific evidence [4,5]. The most commonly reported aural symptoms in TMD patients are otalgia, tinnitus, vertigo and subjective hearing loss [6-8]. Studies suggest most TMD patients who have otologic symptom improvement from TMD therapy maintain their otologic symptom improvement over time (Table 1).

| Tinnitus and TMD | | | | | | |
|---------------------------|---------------------------------|-----------------|--------------------|--------------------|--------------------------------|------------------------------|
| Study authors | TMD patients with tinnitus (%) | No. of Subjects | Tinnitus resolved | Tinnitus improved | Tinnitus resolved or improved | No change in Tinnitus % [n] |
| Bush [6] | 33 | 35 | 31 (11) | 54 (19) | 86 (30) | 14 (5) |
| Wright [9] | 35 | 132 | 55 (72) | 28 (37) | 83 (110) | 17 (23) |
| Kerstein [10] | 23 | 23 | - | - | 83 (19) | 17 (4) |
| Kull and Leary [11] | 55 | 117 | - | - | 76 (135) | 24 (42) |
| Simmons and Gibbs [12] | 66 | - | 64 (41) | 31 (20) | 95 (61) | 5 (3) |
| Wright and Bifano [13] | 38 | 93 | 56 (52) | 39 (28) | 86 (80) | 14 (13) |
| Otalgia and TMD | | | | | | |
| Study authors | TMD patients with otalgia (%) | No. of Subjects | otalgia resolved | otalgia improved | otalgia resolved or improved | No change in otalgia % [n] |
| Cooper and Kleinberg [14] | 51 | 162 | 88 (142) | - | - | - |
| Wright [9] | 33 | 125 | 70 (87) | 24 (30) | 94 (119) | 6 (8) |
| Simmons and Gibbs [12] | - | - | 71 (55) | 23 (18) | 95 (73) | 5 (4) |
| Keersmaekers [15] | 42 | 167 | 48 | - | - | - |
| Dizziness and TMD | | | | | | |
| Study authors | TMD patients with Dizziness (%) | No. of Subjects | Dizziness resolved | Dizziness improved | Dizziness resolved or improved | No change in Dizziness % [n] |
| Wright [9] | 20 | 75 | 63 (47) | 28 (21) | 91 (66) | 9(7) |
| Cooper and Kleinberg [14] | 37 | 117 | 82 (96) | - | - | - |
| Kull [11] | 45 | 144 | - | - | 90 (129) | 10 (15) |

Table 1. Otologic symptoms change following TMD therapy.

In studies, tinnitus has been found to be significantly more prevalent among TMD patients than matched control groups without TMD [1,7]. The prevalence of tinnitus among patients attending TMD clinics has been reported to vary from 33% to 76% [1,13,16]. Many of the same therapies have independently been found beneficial for both TMD and Tinnitus patients, eg biofeedback, relaxation, cognitive therapy, benzodiazepines, and tricyclic antidepressants [16-18]. Among TMD patients with coexisting tinnitus, 46-95% report improvement of their tinnitus following TMD therapy [6,9,13,19].

Otalgia is also a very common symptom of functional disturbances of the masticatory system [5]. TMD appears to be one of the most common causes for non-otologic otalgia (ear pain that is not due to the ear) [17]. The frequency of otalgia in patients with TMD reported 5% to 42% [15]. Kitsoulis found that 10.8% of TMD subjects reported ear pain, and that 75% of those TMD subjects had severe TMD [20]. Among TMD patients with coexisting otalgia, 48-88% report resolution of their otalgia following TMD therapy [9,15].

Vertigo or dizziness is a false sensation of movement or spinning or whirling motion and it occurs when the body's equilibrium is upset. The prevalence of vertigo in TMD patients is reported to range from 40% to 70% [1]. It is well documented that TMD patients with tinnitus and vertigo have

higher pain and dysfunction scores than do TMD patients without otologic symptoms [13,17]. Among TMD patients with coexisting dizziness, approximately 90% report improvement of their dizziness following TMD therapy [9, 14].

Hypothesis for the Association between Otologic and TMD Symptoms

The association between aural symptoms and TMD symptoms has been variously related to the position of the mandible and TMJ, retrusion of the condyles and spasm of the tensor tympani and stapedius muscles [21]. Other evidence has suggested an anatomical link between the TMJ and the middle ear through the mandibular-malleolar or diskomalleolar ligament, and neuromuscular interrelationships between the TMJ and the middle ear [21,22].

The majority of TMD patients have masticatory myofascial pain and it has been speculated that aggravation of myofascial trigger points may cause otologic symptoms via CNS interactions similar to that of trigger points causing pain to be referred to distant locations [23]. It has also been theorized that hyperactivity of the masticatory muscles may induce a secondary reflex contraction of the tensor veli palatine muscle causing ineffective Eustachian tube opening, but a more recent electromyography (EMG) study does not support this theory [24-26].

These studies on the relationship between aural symptoms and TMD have been mainly patient-based studies. However, few population studies have been published concerning the relationship between aural symptoms and TMD in adolescents or middle aged population [2,6,15]. To date, few studies have focused on young adults. Among these diverse TMD and otologic symptom association hypothesis, it appears that further research is necessary before a consensus opinion will develop.

Headache and Other Craniofacial Pain Conditions

TMD is classified as a subset of primary headache disorders by the International Headache Society [27]. Findings from epidemiological and experimental-intervention studies indicate that TMD is a chronic pain condition that can occur in association with some other common chronic pain conditions, notably headaches, pain in the neck and shoulder area and back pain. The presence of large number of possible etiologic factors in patients with headache and TMJ pain requires accurate evaluation of their relevance, temporal sequence of their occurrence, and the mechanisms through which different factors, reciprocally, may enhance one another. Headache is regarded as the most common symptom (22%) of TMD patients, while 55% of chronic headache patients referred to a neurologist had signs or symptoms of TMD [20, 28]. Mongini and co-workers found that at the baseline 70.2% of the subjects with pain had myogenous pain associated with headache while only 18.2 % had headache without myogenous pain, and 11.5% had myogenous pain without headache [29].

While in general, subjects in the study group reported more than a 40% reduction in headache and myogenous pain, the subgroup analysis showed that the benefit was particularly greater in the subjects with both headache and myogenous pain [29].

Patients with arthogenous TMJ disorder having clinical signs and symptoms such as joint noises, pain at joint palpation, jerky jaw movements and bony change in shape, the TMJ is the sole or main source of pain, and mastication is always an aggravating factor. Investigations evaluating associations between headache and TMD could therefore be of practical relevance with both clinical and social implications. However, any hypothetical causal relationship remains difficult to establish. Further, because few population-based studies have been performed, little is known about the epidemiology of these relationships in the general population.

The Impact of Depression on TMD's

Depression is the psychological mood characterized by feelings of sadness, helplessness, hopelessness, guilt, despair, and futility and which have been implicated by some in the initiation of TMD [30]. The prevalence of depression was highest in FPD patients (44.9%) [31]. Studies suggested that anxiety and depression independently increased the probability of having a higher muscle tenderness score. Studies using electromyography (EMG) devices and JAWs tracking system to monitor nocturnal muscle activity have demonstrated a strong relationship between stressful events, increased masseter activity, and reported pain levels [32]. Although there is no consensus regarding the percentage of TMD patients in whom depression play a role, it is clear that this possibility needs to be taken into account to properly diagnose and plan management strategies.

Materials and Methods

There are still controversies about the relevance of etiologic factors in the different head pain pathologies. This, in particular, is true in facial pain conditions frequently referred to as temporomandibular disorders (TMD). More recently, this association between otologic symptoms, headache, depression and TMD was investigated in a first year university students ($n=2,459$) population in Japan. They were participants in the general and oral examinations at the Health and Medical Center of Okayama University in April, 2008. Before the dental examination each subject completed a self-administered questionnaire regarding experiences of tinnitus, otalgia, vertigo, headache, depression, shoulder pain, and symptoms of TMD. Students who met the exclusion criteria ($N=348$) or who provided incomplete data ($N=181$), were excluded from the study [32]. A total of 1,930 subjects (981 males and 949 females, respectively; 18.6 ± 2.1 years old, mean \pm S.D.) satisfied the inclusion criteria and were analyzed.

Questionnaire

A standardized student's health questionnaire was used for all students. This questionnaire consisted of questions relating to a range of dental, medical, and aural complaints. Before starting the study, the specific contexts of the questions was explained to all subjects and where necessary question meaning were double checked with subjects to ensure that they understood correctly. The questions were designed to elicit a yes or no answer. Questions to distinguish TMD-positive cases from TMD-negative cases in accordance with previous studies [28,33,34] were "During the past 2 months, (i) Have you ever noticed any sounds around your ears? (Clicking), (ii) Have you ever felt pain around your ears while opening your mouth or chewing food? (Pain in TMJ), and (iii) Have you ever felt difficulty in opening your mouth? (Difficulty in mouth opening)." Each question was answered by selecting a description of awareness (frequently, sometimes, rarely, or never). The reliability of such questionnaires has been verified by other studies [33,34].

Statistical Analysis

The data were analyzed using the software package, SPSS (version 17.0, Family, SPSS Inc., Chicago, IL, USA). The subjects were arbitrarily separated into a TMD-positive group (frequently or sometimes aware of TMD symptoms) and TMD-negative group (rarely/never aware of TMD symptoms). Yes (%) answers by respondents having otalgia, vertigo, tinnitus, headache, depression and shoulder pain were compared between the groups using Bonferoni correction to adjust probability [7]. For instance, when group I (clicking only) was associated with one of these 6 categories, the number of comparisons was 6 and p-values below $0.05/6 = 0.008$ were considered significant. Based on the results of bivariate analysis, variables associated with TMD symptoms were selected as possible factors related to TMD. Furthermore, the strength of association between TMD symptoms and these factors was expressed as an odds ratio (OR) and a 95% confidence interval (CI) using logistic regression models. Probability levels of $P < 0.05$ were considered to be statistically significant.

Results and Discussion

The distribution of frequencies of temporomandibular disorder (TMD) symptoms is shown in Table 2.

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| Group | TMD symptoms | Frequency | Percent (%) |
|--------------|--|-----------|-------------|
| TMD-negative | | 1,387 | 71.9 |
| TMD-positive | | 543 | 28.1 |
| I | Clicking only | 319 | 16.5 |
| II | Pain in TMJ only | 21 | 1.1 |
| III | Difficulty in mouth opening only | 18 | 0.9 |
| IV | Clicking and pain in TMJ | 29 | 1.5 |
| V | Clicking and difficulty in mouth opening | 48 | 2.5 |
| VI | Pain in TMJ and difficulty in mouth opening | 11 | 0.6 |
| VII | Clicking, pain in TMJ and diff. in mouth opening | 97 | 5.0 |
| Total | | 1,930 | 100.0 |

Table 2. Frequencies of symptoms of TMD

| Variables | TMD-negative group | TMD-positive groups | | | | | | |
|------------------|--------------------|---------------------|------|------|------|------|------|------|
| | | I | II | III | IV | V | VI | VII |
| Age | | | | | | | | |
| 18 years | 78.4 | 82.8 | 71.4 | 72.2 | 79.3 | 81.3 | 72.7 | 71.1 |
| 19 years or more | 21.6 | 17.2 | 28.6 | 27.8 | 20.7 | 18.8 | 27.3 | 28.9 |
| Gender | | | | | | | | |
| Male | 52.1 | 50.2 | 42.9 | 44.4 | 41.4 | 54.2 | 27.3 | 42.3 |
| Female | 47.9 | 49.8 | 57.1 | 55.6 | 58.6 | 45.8 | 72.7 | 57.7 |

Table 3. Percent distributions of age and gender according to TMD symptoms-positive and TMD symptoms-negative groups.

There were no observed significant differences for age and gender distribution between any of TMD-positive students and TMD-negative students (Table 3). Although, percentages of female subjects in all TMD-positive groups were higher than the TMD-negative group except for group I and group V.

In terms of the relationships of TMD symptoms to otalgia, vertigo, tinnitus, headache, shoulder pain and depression, the percentage of subjects experiencing vertigo was significantly greater in the TMD-positive groups I, II, III, IV and V than in the TMD-negative group. The percentage of subjects experiencing tinnitus was also significantly greater in the TMD-positive groups II and IV. Significant associations were observed between the percentages of subjects experiencing headache and TMD-positive groups I, II, III, IV and VII. The percentage of subjects who were depressed and had a history of otalgia was higher in group I than those in the TMD-negative group. When the variables were analyzed together adjusting for age and gender, the strongest association was seen between TMD symptoms and otalgia, tinnitus, vertigo and headache (Table 4).

| TMD symptoms | Significant factors (Odds ratio and 95% CI) * | | | | |
|---|---|-----------------------|-----------------------|-------------------------|------------|
| | Tinnitus | Vertigo | Otalgia | Headache | Depression |
| Group I (Clicking) | 1.55** (1.12-2.15) | 1.34 * (1.02-1.75) | 1.36 * (1.01-1.83) | 1.85*** (1.37-2.50) | |
| Group II (Pain in TMJ) | 12.07 *** (4.78-30.52) | 2.77* (1.05-7.32) | | 5.76*** (2.23-14.85) | |
| Group III (Difficulty in mouth opening) | | 2.94* (1.06-8.10) | | 3.04* (1.16-8.00) | |
| Group IV (Clicking and pain in TMJ) | 13.22 *** (5.75-30.39) | | | 8.30*** (3.40-20.29) | |
| Group V (Clicking and difficulty in mouth opening) | | 2.61** (1.36-5.04) | | | |
| Group VII (Clicking, pain in TMJ and difficulty in mouth opening) | | | | 2.04* (1.29-3.21) | |

*: P<0.05, *: P<0.01, ***: P<0.001, adjusted by age and gender
 * Reference category: no aural symptoms

Table 4. Results of multiple logistic regression analysis after adjustment for age and gender.

Subjects who reported symptoms of depression were significantly associated with only group I TMD- positive symptom. In previous studies, vertigo and tinnitus have been reported as aural symptoms in functional disturbances of the masticatory system [24,32]. Several studies

have also noted otologic complaints more often in subjects with TMD than in those without TMD [6,21,22]. This epidemiological study in young adult population also confirmed the results. The reported prevalence of otological complaints in TMD patients varies in the literature. The most relevant article to this work is a comparably controlled study of otic symptoms in TMD by Tuz et al. In their 155 study patients with TMD who reported having aural symptoms, the frequency of tinnitus was 59%, whereas in this study subjects, the frequency was 39%. The difference might reflect the older population in their study group (mean age, 49.1 years) who may be more likely to have aural symptoms than this younger study group (mean age, 18.6 years). Findings showed a relatively strong correlation between tinnitus and subjects having pain in the TMJ (group II) and the combination of clicking and pain in the TMJ (group IV) after adjusting for age and gender in the logistic regression analyses. There is evidence for a link between tinnitus and pain in the TMJ [21]. Tinnitus has been associated with pain upon pressure in the masticatory muscles and the TMJ, mandibular overclosure and posterior displacement of the condyle [24,35]. Tinnitus may have a central component (as opposed to cochlear tinnitus) but can be modified both by voluntary orofacial movements (including tooth clenching) and purely sensory stimuli [2].

Data in this study was consistent with previous findings suggesting there may be a link between TMD and postural imbalance leading to a dizzy. The frequency of vertigo in patients with TMD ranges from 40% to 70% in a study by Ramirez et al. [36], whereas in this study it was 12 to 50%. The reason for this discrepancy might be due to the different types of study subjects. Ramirez et al. [36] studied only an older patient population where vertigo might be more frequent, whereas this study subjects were 1st year healthy university students who might have less tendency to vertigo. It has been suggested that malpositioning of the mandibular condyle as a result of TMD could lead to eustachian tube blockage and symptoms of aural pain and vertigo[4]. Significantly more patients in a TMD group (70%) also reported vertigo than in a control group (31%) in Chole and Parker’s study [7]. A high incidence of vertigo in their subjects with TMD may relate to the possibility that underlying emotional distress may exacerbate vertigo. Parker and Chole [1] stated that TMD and vertigo are associated with emotional disorders. However, the pathogenesis of the symptom of vertigo in subjects with TMD is still unknown.

Otalgia is often considered to be a referred pain of orofacial origin, but it could be speculated that otalgia and the sensitivity of the ear canal are influenced by chemical mediators of inflammation [37] associated with the contiguous TMJ. In this study, the prevalence of otalgia in TMD subjects was 34%. The findings of the present study were consistent with other studies [1,5]. The otalgia may possibly be explained by the proximity of the temporomandibular joint and the structures of the ear. It may be the

consequence of a mechanical irritation of the auriculotemporal nerve or of some interference into the petrotympanic fissure region due to an articular inflammatory-degenerative state [15]. The cause of otalgia in patients with TMD without a pathological condition in the ears or nasopharynx is explained as referred pain from the masticatory muscles or temporomandibular joints [5]. Therefore patients without infection should be referred to a dentist with stomatognathic experience to rule out stomatognathic causes of aural symptoms.

Patients diagnosed with painful TMDs often report having headaches [38]. The prevalence (21.9%) of headache in this population is within the range of other studies conducted on Asian Chinese (24.2%), Japanese (22.8%), European (21.9%) and northern American populations (13-21%) [39-41]. In a univariate analysis of this data, headache was associated with symptoms of TMD as a whole and this relationship remained significant also after adjustment for age and sex. For headache, this study found a significant risk between subjects with and without symptoms of TMD. The high OR for group II (12.1) and IV (13.2) suggests that in the young adult population, the relationship between headache and TMD may be primarily expressed as pain in the TMJ region. Owing to the cross-sectional study design in this project no etiological conclusions can be drawn and caution should be paid because no clinical confirmation of the location of pain was available.

Depression causes an increase in muscular tension which spreads to the pericranium muscles and might act as a cause for TMD symptoms. Several studies have shown that many TMD patients are depressed [30,42]. This study confirms and extends previous reports addressing the association between depression and TMD populations.

Methodological Limitations

All data analyzed in this study were collected from written questionnaires. It is recognized that the data relied on memory and self reporting. The authors recognize that there might have been possible incorrect answers to questions. Another limitation of this study is the absence of clinical diagnosis of TMD in the subjects. Since the clinically determined prevalence (point prevalence) might be less than the prevalence of TMD symptoms reported on the questionnaires (period prevalence), this study used period prevalence as the diagnostic criterion for TMD. The results of several studies also support the validity of questionnaires for epidemiological studies on TMD symptoms [43,44]. An additional limitation was medical records were not analyzed, nor was a standardized questionnaire for assessing depression used.

Conclusions and Future Perspective

A considerable number of otolaryngology patients have TMD symptoms, and many adult patients whose chief com-

plaint is ear pain are found not to have an otologic source for the pain. The association of these symptoms does not prove a causal relationship, but investigations of this association may improve our understanding of both TMD and the otologic symptoms of tinnitus and vertigo especially in a young adult population. The association between headache and the TMD groups suggests that headache may be a risk factor for the development of TMD, or that TMD could be a risk factor for development of headache. It is hoped that more medical providers will identify patients with otologic symptom complaints who have coexisting TMD and consider reducing the impact of these disorders on their patient's otologic symptoms. Furthermore, patients with TMD pain should be screened for comorbid psychiatric disorder (eg. depression) as part of their clinical evaluation. This study would also be important to find potential TMD patients and prevent the progress of TMD. Further collaborative research is needed to better identify which patients with otologic symptoms and negative otologic findings are the most likely to have otologic symptom improvement from masticatory therapies.

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