

Painful temporomandibular disorders, self reported tinnitus, and depression are highly associated

Disfunção temporomandibular dolorosa, auto-relato de zumbido e depressão estão fortemente associados

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ABSTRACT

Objective: The aim of this study was to investigate the association among painful temporomandibular disorders (TMD), self reported tinnitus, and levels of depression. **Method:** The sample consisted of 224 individuals with ages ranges from 18 to 76 years. The Research Diagnostic Criteria for Temporomandibular Disorders Axis I were used to classify TMD and Axis II were used for self reported tinnitus, and to score the levels of depression. The odds ratio (OR) with 95% confidence interval (CI) was applied. **Results:** The presence of painful TMD without tinnitus was significantly associated with moderate/severe levels of depression (OR=9.3, 95%; CI: 3.44-25.11). The concomitant presence of painful TMD and tinnitus self-report increased the magnitude of the association with moderate/severe levels of depression (OR=16.3, 95%; CI: 6.58-40.51). **Conclusion:** Painful temporomandibular disorders, high levels of depression, and self reported tinnitus are deeply associated. However, this association does not imply a causal relationship.

Keywords: depression, facial pain, tinnitus.

RESUMO

Objetivo: Investigar a associação entre disfunção temporomandibular (DTM) dolorosa, auto-relato de zumbido e níveis de depressão. **Método:** A amostra foi composta por 224 indivíduos com idades de 18 a 76 anos. O *Research Diagnostic Criteria for Temporomandibular Disorders*, eixo I, foi usado para classificar a DTM e o eixo II para obtenção do auto-relato de zumbido e dos níveis de depressão. Para a análise dos dados, foi aplicado o teste *odds ratio* (OR) com intervalo de confiança (IC) de 95%. **Resultado:** Somente a presença de DTM dolorosa estava significativamente associada aos níveis de depressão moderado/severo (OR=9,3, 95%; IC: 3,44-25,11). A presença concomitante de DTM dolorosa e auto-relato de zumbido aumentaram a magnitude da associação com os níveis de depressão moderado/severo (OR=16,3; 95% IC: 6,58-40,51). **Conclusão:** Disfunção temporomandibular dolorosa, altos níveis de depressão e auto-relato de zumbido estão fortemente associados. Entretanto, o desenho do estudo não permite estabelecer uma relação causal entre essas três entidades.

Palavras-chave: depressão, dor facial, zumbido.

Tinnitus is defined as a phantom sensation because sound is perceived in the absence of a physical sound source¹. It is clinically heterogeneous, reflecting multiple etiologies, and its complexity is related to its biological and psychological components².

Studies have observed tinnitus complaints more often in patients with temporomandibular disorders (TMD) than in those without TMD³⁻⁴, and tinnitus patients had more TMD signs and symptoms⁵. Furthermore, signs of TMD may be a risk factor for the development of tinnitus⁶.

Temporomandibular disorders refer to a group of conditions characterized by signs and symptoms, including pain in the temporomandibular joint (TMJ), and/or masticatory muscles, and/or TMJ sounds, and deviations or restriction in mandibular range of motion⁷.

The first hypothesis for the association between tinnitus and TMD was described by Costen⁸, in 1934. Since then several hypotheses have been proposed⁹⁻¹⁰, but at present the most accept hypothesis is based on neural plasticity,

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especially the plasticity of somatosensory inputs to the cochlear nucleus¹¹⁻¹².

Interestingly, high levels of depression have been associated with both conditions – tinnitus and TMD. As regards TMD, the literature findings suggest an association between this dysfunction and depression in different groups of TMD patients¹³⁻¹⁴, and the presence of chronic pain may be an important factor in this association¹⁴. On the other hand, tinnitus is considered a debilitating disorder, significantly associated with higher levels of depression^{5,15}, and this overall association was independent of the presence or absence of the other health conditions¹⁶. Based on these statements, we hypothesize a possible triple association among chronic painful TMD, tinnitus, and depression. Therefore, the aim of the present cross-sectional, clinically-based study was to investigate a possible association among these three entities, assessing the odds of occurrence of moderate/severe depression levels in patients with or without painful TMD and tinnitus.

METHOD

The sample consisted of 233 individuals: 183 adults consecutively recruited among patients with the chief symptom of orofacial pain, who sought care at a University-based specialty clinic (Universidade Estadual Paulista, Brazil). Fifty individuals without history of facial pain, and absence of TMD were also indentified and selected among patients seeking routine dental treatment at the same university.

Exclusion criteria were the presence of odontalgia, neuropathy, intra-oral lesions, any chronic pain syndrome, impairments in cognition or language, individuals under 18 years of age, and presence of TMD pain for less than six months, which according to the International Association Study for the Pain³⁰ (IASP) is considered acute pain. Among the 233 individuals examined, nine were excluded because of the exclusion criteria. Overall, no individuals refused to participate in the study.

This study was approved by the Research Ethics Committee, Araraquara School of Dentistry (Universidade Estadual Paulista, Brazil). A signed term of free and informed consent was obtained from each participant.

TMD evaluation

A standardized diagnostic protocol was applied to all patients equally by only one experience and trained dentist in accordance with the following instruments:

Orofacial Pain Clinic Protocol: first, all participants were interviewed and systematically examined. Cervical, cranial, facial, dental and the other oral structures were evaluated. The objective was to detail the chief complaint, general pain characteristics (location, intensity, quality, duration, time of pain worsening, aggravation and alleviating factors) and

medical history. The American Academy of Orofacial Pain⁷ (AAOP) diagnostic criteria were applied for the differential diagnoses with other conditions that may mimic TMD.

Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), Portuguese version¹⁸⁻²¹. The RDC/TMD is largely used and details of its application are described elsewhere. In brief, questionnaire assessment and physical examination allow a dual axis approach to TMD assessment. The questionnaire was self reported. Study investigators were available when clarification was needed, but did not interfere with the responses. Axis I allows the physical pathology classification of TMD into 3 subtypes and 8 subgroups. Axis II of RDC/TMD assesses another domain, the psychological status. The Axis II Depression instrument have clinically relevant and acceptable psychometric properties for reliability and validity and use as instruments for indentifying TMD patients with high levels of distress, pain, and disability²². The RDC/TMD was applied to confirm and classify the absence or presence of TMD. Based on the Axis I of the RDC/TMD, patients were stratified according to their TMD status into: (1) No painful TMD (only disc displacement with reduction or disc displacement without reduction, with or without limited opening or non-TMD and/or osteoarthrosis) and (2) Painful TMD (myofascial pain with or without limited opening, and/or TMJ arthralgia and/or osteoarthritis).

Self reported tinnitus

The RDC/TMD questionnaire allowed obtainment of self reported tinnitus by means of the question “Do you have noises or ringing in your ears?”

Finally, the study could be considered blind, since the RDC/TMD questionnaire is a self reported instrument and the examiner did not know the answers about tinnitus and level of depression grades while performing the physical examination of the TMD.

Data analysis

The sample was stratified according to the absence or presence of painful TMD and tinnitus to verify the association between them and also their isolated association with levels of depression. Furthermore, the sample was stratified according to the simultaneous presence of painful TMD and tinnitus to study the association with levels of depression. Statistical analyses were performed using SPSS 15.0 for Windows and GraphPadInStat 3.06. The Chi-Square Test, and odds ratio (OR) with 95% confidence interval (CI) were applied, and the significance level adopted was 0.05.

RESULTS

The final sample consisted of 224 individuals (82.1% women). Mean age was 37.4 years for women and 38.6 years

for men ($p=0.679$). The majority of individuals had completed high school (47.3%), was married (58%), and was white (78.1%) (Table 1).

From participants, 62 (27.7%) presented no TMD ($n=48$) or no painful TMD ($n=14$) and 162 (72.3%) presented chronic painful TMD patients (myofascial pain and/or TMJ arthralgia and/or osteoarthritis). Table 2 shows painful TMD diagnoses as a function of tinnitus self-report. When compared with reference group, the presence of painful TMD increased the odds of tinnitus self-report ($p<0.0001$; OR=7.4, 95% CI: 3.80-14.57).

As regards the levels of depression (RDC/TMD, Axis II), the presence of painful TMD increased the odds for moderate/severe depression levels ($p<0.0001$; OR=11.3, 95%CI: 5.44-23.65) (Table 3), as well as tinnitus self-report ($p<0.0001$; OR=4.0, 95% CI: 2.25-7.12) (Table 4). When the sample was stratified by the presence of tinnitus self-report and painful TMD, the presence of painful TMD without tinnitus was significantly associated with moderate/severe levels of depression (OR=9.3, 95%; CI, 3.44-25.11). The concomitant presence of painful TMD and tinnitus self-report increased the magnitude of the association with moderate/severe levels of depression (OR=16.3, 95%; CI: 6.58-40.51) (Table 5).

DISCUSSION

Several studies have explored the association between high levels of depression and tinnitus, and high levels of

depression and TMD, both separately. Thus, to our knowledge, there is a lack of researches investigating multiple associations. Tinnitus, TMD and depression are highly prevalent and present great impact on individuals' lives, thus the findings of the present study contribute to the contemporary knowledge.

The most important findings were: (1) There was an association between painful TMD and tinnitus self-report; (2) An association was also found between painful TMD and moderate/severe levels of depression; (3) With regard to tinnitus, there was significant association with moderate/severe levels of depression. (4) In patients with concomitant painful TMD with tinnitus self-report the magnitude of association with moderate/severe levels of depression was higher than that observed for painful TMD without tinnitus self-report patients.

A fair number of studies have demonstrated an association between TMD and tinnitus³⁻⁶. The most plausible hypothesis for this association is that painful somatosensory stimuli originating from the face and TMJ (via the trigeminal nerve and spinal trigeminal tract), and neck (via the C2 dorsal root) could increase the activity of the cochlear nucleus (CN) in the auditory pathways, since it receives an excitatory projection from the somatosensory pathway. Increased activity in the CN (through pain impulses from the somatosensory pathway) would then be relayed to higher auditory centers, resulting in tinnitus¹². In spite of the lack of details about the onset of tinnitus and other possible contributory factors presented in the patients' life, in the present study, painful TMD may be considered a potential risk factor for tinnitus.

Recently, imaging studies have also demonstrated a high activation of non-auditory, limbic brain structures, such as the hippocampus and amygdala in tinnitus patients²³, especially in the subcallosal area, in which there was a significant decrease of gray-matter volume²⁴. The subcallosal area contains dopaminergic and serotonergic neurons and is associated with reduced serotonin levels in the brain. A serotonergic dysfunction is implicated in a number of clinically-relevant conditions, including depression²⁵.

An interesting finding of this study is precisely this association, in which the moderate/severe levels of depression are associated with tinnitus self-report. The relationship between high levels of depression and tinnitus is likely to be bidirectional. It seems that tinnitus leads to an increased level of depression but also that depression decreases tolerance to tinnitus, which in turn may lead to a "vicious circle"¹⁶.

Interestingly, from the psychological aspect, the perception of tinnitus has many characteristics in common with the perception of chronic pain. The same "vicious circle" happens, in other words, TMD is associated to an increased level of depression and this, in turn, can be associated with painful TMD¹³⁻¹⁴, which may be seen accurately in the results of the present study.

Table 1. Demographic characteristics of the sample ($n=224$).

| Number | Total | % | Women (%) | Men (%) |
|---------------------|---------|------|------------|-----------|
| Gender Distribution | 224 | | 184 (82.1) | 40 (17.9) |
| Age | | | | |
| Mean | 37.7 | | 37.4 | 38.6 |
| Standard deviation | 12.6 | | 12.5 | 13.2 |
| Range | (18-76) | | (18-76) | (18-62) |
| Educational Level | | | | |
| <Middle School | 55 | 24.6 | 49 (26.6) | 6 (15.0) |
| High School | 106 | 47.3 | 89(48.4) | 17 (42.5) |
| College | 56 | 25.0 | 41(22.3) | 15 (37.5) |
| Missing | 7 | 3.1 | 5 (2.7) | 2 (5.0) |
| Marital Status | | | | |
| Married | 130 | 58.0 | 105 (57.1) | 25 (62.5) |
| Single | 66 | 29.5 | 52 (28.3) | 14 (35.0) |
| Separated/divorced | 21 | 9.4 | 20 (10.9) | 1 (2.5) |
| Widower | 6 | 2.7 | 6 (3.3) | 0 (0.0) |
| Missing | 1 | 0.4 | 1 (0.4) | 0 (0.0) |
| Race | | | | |
| White | 175 | 78.1 | 139 (75.5) | 36 (90.0) |
| Black | 20 | 8.9 | 18 (9.8) | 2 (5.0) |
| Mulatto | 16 | 7.1 | 14 (7.6) | 2 (5.0) |
| Asian | 1 | 0.4 | 1 (0.6) | 0 (0.0) |
| Missing | 12 | 5.5 | 12 (6.5) | 0 (0.0) |

Table 2. Association between tinnitus self-report and painful TMD.

| | No TMD or non painful TMD n (%) | Painful TMD n (%) | Total n (%) | OR 95% IC |
|-------|------------------------------------|----------------------|----------------|------------------------------|
| No T | 47 (49.5) | 48 (50.5) | 95 (100.0) | Reference |
| T | 15 (11.6) | 114(88.4) | 129 (100.0) | 7.4 (3.80-14.57) p<0.0001 |
| Total | 62(27.7) | 162 (72.3) | 224(100.0) | |

TMD: temporomandibular disorder; T: tinnitus.

Table 3. Association between painful TMD and levels of depression (Research Diagnostic Criteria for Temporomandibular Disorders, Axis II).

| Levels of depression | No TMD or non painful TMD n (%) | Painful TMD n (%) | Total n (%) | OR 95% IC |
|----------------------|------------------------------------|----------------------|----------------|-------------------------------|
| Normal | 51 (52.0) | 47 (48.0) | 98 (100.0) | Reference |
| Moderate/severe | 11 (8.7) | 115 (91.3) | 126 (100) | 11.3 (5.44-23.65) p<0.0001 |
| Total | 62 (27.7) | 162 (72.3) | 224(100.0) | |

TMD: temporomandibular disorders.

Table 4. Association between tinnitus self-report and levels of depression (Research Diagnostic Criteria for Temporomandibular Disorders, Axis II).

| Levels of depression | Tinnitus self-report | | Total n (%) | OR 95% IC |
|----------------------|----------------------|-------------------|-------------|-----------------------------|
| | Absence n (%) | Presence n (%) | | |
| Normal | 58 (58.6) | 41 (41.4) | 99 (100.0) | Reference |
| Moderate/severe | 37(29.6) | 88 (70.4) | 125 (100) | 4.0 (2.25-7.12) p<0.0001 |
| Total | 95 (42.4) | 129 (57.6) | 224(100.0) | |

Table 5. Association between painful TMD and tinnitus self-report with levels of depression (Research Diagnostic Criteria for Temporomandibular Disorders, Axis II).

| | Levels of depression | | Total n (%) | OR 95% CI |
|-------------------------------|----------------------|--------------------------|----------------|-------------------------------|
| | Normal n (%) | Moderate/severe n (%) | | |
| No TMD or non painful TMD - T | 39 (39.8) | 7 (5.5) | 46 (20.6) | Reference |
| No TMD or non painful TMD + T | 12 (12.2) | 4 (3.2) | 16 (7.1) | 1.9 (0.46-7.45) p=0.6154 |
| Painful TMD - T | 18 (18.4) | 30 (23.8) | 48 (21.4) | 9.3 (3.44-25.11) p<0.0001 |
| Painful TMD + T | 29 (29.6) | 85 (67.5) | 114 (50.9) | 16.3 (6.58-40.51) p<0.0001 |
| Total | 98 (100.0) | 126 (100.0) | 224 (100.0) | |

TMD: temporomandibular disorders; T: tinnitus.

In this multiple association, it may be suggested that two sources will be acting in the limbic system accentuating the levels of depression. This increase could worsen the severity of TMD and tinnitus. Furthermore, more severe TMD could act in the maintenance of tinnitus. Higher degrees of TMD and tinnitus severity would lead to even higher levels of depression. This "vicious circle" may explain one of the reasons why painful TMD patients with tinnitus more often present Grade 2, 3 and 4 of the chronic pain scale than patients with

painful TMD without tinnitus, as they would have a greater pain intensity and disability.

This multiple association may make the patient with pain and tinnitus more biologically and psychologically complex, and this should be reflected in the diagnosis and therapy.

This study has several limitations. Firstly, the study sample consisted of adults who sought care at a University-based orofacial pain specialty clinic, and therefore, is not representative of the general population. Secondly, the reference

group was small, which probably tends to increase the overall odds ratios and patients were not evaluated for diagnoses of otologic diseases. Future studies using control groups adjusted for age and sex, and with the participation of an otolaryngologist are highly recommended.

As regards interpretation of the results in terms of a potential causal link between tinnitus, TMD and depression, in a cross-sectional study, caution is needed. One cannot draw conclusions about whether depression is the consequence of the clinical symptoms or the expression of an underlying psychological potential risk factor for TMD or tinnitus. Obviously, the causal relationship among the entities cannot be established and goes far beyond that which the study design can affirm. In order to establish a causal relationship, appropriate studies with a longitudinal design are necessary. However, this study reflects an important characteristic of the sample: high percentages of individuals with chronic painful TMD and tinnitus self-report also presenting high levels of depression.

The strengths of this study include the use of RDC/TMD, which are internationally accepted criteria¹⁸, including Axis

II depression with acceptable psychometric properties²². Moreover, data were collected by 1 trained and experienced, blinded researcher. These characteristics increase the reliability of the collected data.

In conclusion, the present study shows that tinnitus self-report, chronic painful TMD and high levels of depression are deeply associated. However, this association does not imply a causal relationship. It is important for clinicians to understand this concept to avoid overly simplistic strategies when diagnosing and managing tinnitus, since tinnitus has been viewed as complex, multidimensional developmental processes where various physical, psychosocial and environmental factors are of the utmost importance. The interaction between otolaryngologists and dentists is strongly recommended when evaluating and managing patients suffering from chronic painful TMD and tinnitus.

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