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Audiological findings in patients with subjective tinnitus associated with TMD

Achados audiológicos em portadores de zumbido subjetivo associado a DTM

Hallazgos audiológicos en portadores de zumbido subjetivo asociado a DTM

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Abstract

Introduction: Otologic symptoms are frequent in patients with temporomandibular dysfunction, among these symptoms the prevalence of tinnitus is outstanding. In the literature we highlight several studies that prove this association, although the audiological and otorhinolaryngological evaluation are within the norms of normality. Despite many studies involving multiprofessional teams, it was not possible to clarify the association of auditory symptoms and TMD. **Objective**: To investigate hearing health in patients with tinnitus associated with TMD in the dental pre-treatment stage. **Methodology**: Fifty-three patients from the Orthodontics and Audiology clinics of Faculdade de Odontologia de Bauru, Universidade de São Paulo were evaluated. To investigate auditory health, the participants performed a specific interview, conventional and high frequency tonal audiometry, logoaudiometry, immitanciometry and otoacoustic emissions. **Results**: Unilateral tinnitus was reported by most individuals, with atrial fullness and no otalgia. The majority of the subjects presented normal hearing bilaterally, followed by moderate loss. **Conclusion**: The results evidenced that the occurrence of auditory alterations in patients with TMD is significant, and audiological follow-up should be indicated in patients with TMD.

Keywords: Temporomandibular Joint; Speech, Language and Hearing Sciences; Hearing; Tinnitus

Resumo

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Introdução: Sintomas otológicos são frequentes em pacientes com disfunção temporomandibular, e dentre esses sintomas destaca-se a prevalência do zumbido. Na literatura destacam-se diversos estudos que comprovam essa associação, embora a avaliação audiológica e otorrinolaringológica estejam dentro dos padrões de normalidade. Apesar de muitos estudos envolvendo equipes multiprofissionais, pouco se conseguiu esclarecer a associação de sintomas auditivos e DTM. **Objetivo**: Investigar a saúde auditiva em portadores de zumbido associado à DTM na etapa pré-tratamentos odontológicos. **Metodologia:** Foram avaliados 53 pacientes das clínicas de Ortodontia e Audiologia da Faculdade de Odontologia de Bauru, Universidade de São Paulo. Para investigar a saúde auditiva, os participantes realizaram entrevista específica, audiometria tonal liminar convencional e altas frequências, logoaudiometria, imitanciometria e emissões otoacústicas. **Resultados:** O zumbido unilateral foi relatado pela maioria dos indivíduos, sendo com presença de plenitude auricular, e sem otalgia. A maioria dos sujeitos apresentou audição normal bilateralmente, seguido de perda moderada. **Conclusão:** Os resultados evidenciaram que a ocorrência de alterações auditivas em portadores de DTM é significativa, sendo assim, o acompanhamento audiológico deve ser indicado em portadores de DTM.

Palavras-chave: Articulação Temporomandibular; Fonoaudiologia; Audição; Zumbido.

Resumen

Introducción: Síntomas otológicos son frecuentes en pacientes con disfunción temporamandibular, entre estos síntomas se destaca la prevalencia del zumbido. En la literatura se destacan diversos estudios que comprueban esa asociación, aunque la evaluación audiológica y otorrinolaringológica estén dentro de los patrones de normalidad. A pesar de muchos estudios involucrados en equipos multiprofesionales, poco se pudo aclarar la asociación de síntomas auditivos y DTM. **Objetivo**: Investigar la salud auditiva en portadores de zumbido asociado a la DTM en la etapa pretratamiento odontológico. **Metodología**: Se evaluaron 53 pacientes de las clínicas de Ortodoncia y Audiología de la Faculdade de Odontologia de Bauru, Universidade de São Paulo. Para investigar la salud auditiva, los participantes realizaron una entrevista específica, audiometría tonal liminar convencional y altas frecuencias, logoaudiometría, imitanciometría y emisiones otoacústicas. **Resultados**: El zumbido unilateral fue reportado por la mayoría de los individuos, siendo con presencia de plenitud auricular, y sin otalgia. La mayoría de los sujetos presentaron una audición normal bilateralmente, seguido de una pérdida moderada. **Conclusión**: Los resultados evidenciaron que la ocurrencia de alteraciones auditivas en portadores de DTM es significativa, siendo así, el acompañamiento audiológico debe ser indicado en portadores de DTM.

Palabras claves: Articulación Temporomandibular; Fonoaudiología; la Audición; Acúfeno.

Introduction

The temporomandibular joint (TMJ) is one of the elements of the stomatognathic system. It is responsible for functions such as chewing, swallowing, and phonation. Its stability, health, and function contribute to the balance of functions in the entire body, including body posture[1].

Temporomandibular disorders (TMD) include several clinical symptoms, involving masticatory and articulatory muscles as well as associated structures[2]. TMD and orofacial pain are problems that affect a great number of people and manifest themselves in symptoms in the temporomandibular joint such as headaches and otalgia, cracking, facial pain, among others[2-4]. Temporomandibular joint problems can be either intracapsular (affecting ligaments, head of the mandible, disc, synovial compartments, and fibrous and bone changes of the mandibular fossa) or extracapsular, with changes in the muscular system responsible for mandibular movements[3].

Previous studies have shown that there is no etiological factor responsible for TMD, which means it is a multifactorial disease[5]. Amongst the etiologies, the following can be considered: changes in occlusion, traumatic or degenerative TMJ injuries, skeletal problems, psychological factors, and deleterious habits[1]. Once proven that performing orthodontic procedures does not pre-

dispose individuals to TMD[3,6], the most commonly related factors are malocclusion, emotional factors, dental absences, unilateral mastication, inappropriate oral habits, and others still being studied. Normally one isolated factor only is not enough to cause the dysfunction, but rather the association between them.

TMD can cause several hearing and non-hearing effects. Regarding non-hearing effects, orofacial pain, and cephalgia (persistent and violent headache) can be found. On the other hand, auditory effects can be tinnitus, ear fullness, otalgia, and hearing loss. According to the *International Association for the Study of Pain - IASP*, pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. In temporomandibular dysfunction (TMD), the musculoskeletal conditions of both the cervical region and the mastication muscles are the major cause of non-dental pain in the orofacial region, and such pain is usually located in the preauricular area, radiating to the temporal, frontal, or occipital region[1,3].

It is common for patients with TMJ pain to complain about otological pain. That is because the temporal bone, which is located in the ear, is related to the mandibular condyle, separated only by the tympanic wall. The proximity between the ear, the TMJ, the mastication muscles, and their common innervations in the trigeminal create a persistent condition of reflex pain[1-4]. Otalgia without organic causes is a common symptom in patients with TMD even though the etiology is controversial, and there is little research on the influence of TMD treatment due to otalgia[2,3]. Among the studies on TMJ, a multidisciplinary approach is required involving professionals from the following areas: Physiotherapy, Psychology, Dentistry, Otorhinolaryngology, and Speech-Language Therapy and Audiology[7]. This is due to the fact that the individual should be considered as a whole person, seeking to adapt the mobility of the joints, rehabilitate dental occlusion, reposition the tongue, reeducate postures, balance muscle groups, and guide breathing work, which would improve patients' quality of life and promote their return to daily activities as soon as possible[8-9].

Studies estimate around 85% of the patients with TMD have otorhinolaryngological symptoms, which is the third cause of otalgia, with a prevalence very close to that observed by acute diffuse external otitis[3,4]. In fact, referred pain in the auricular region is very common. The anatomical basis for such condition is the rich sensory innervation of the ear, which consists of branches of the V, VII, IX, and X cranial nerves in addition to high-cervical nerves[5]. Research indicates that the symptoms most commonly associated with otalgia in patients with TMD are cephalgia, tinnitus, dizziness, and vertigo[2-4, 6].

Speech-language pathology and audiology in a multidisciplinary team for rehabilitation of the TMD can work on both auditory and orofacial myology functions[7-9]. Facial myofunctional therapy is a specialty of speech-language pathology and audiology. It diagnoses and treats neuromuscular disorders of the face to provide optimal conditions for the growth and development of the craniofacial complex[7-10]. It is up to the speech-language pathology and audiology professional to assess posture, tone, mobility, and myology of the orofacial musculature as well as the stomatognathic functions. The speech-language pathology and audiology examination also includes assessment of vocal quality and possible hearing problems, which are often associated with TMD[3].

The occurrence of auditory complaints by individuals with TMD was analyzed by recording the transient evoked otoacoustic emissions (TEOAEs), the auditory thresholds of which are within the normal standards [2, 11-12]. This study did not confirm that the TMD has caused any changes in the cochlear amplification mechanism. However, it emphasizes that, due to the high incidence of auditory complaints, the speech-language pathologist and audiologist should consider the hypothesis of changes in the TMJ and make the necessary referrals, even when there is no hearing loss, to achieve appropriate diagnosis and treatment.

A study on patients of both sexes diagnosed with TMD found that all patients reported pain symptoms, 60% of which were auditory. The most cited were tinnitus, otalgia, and ear fullness[1]. The symptoms cited in the study are the most common in people with TMD, even though their etiology has not been defined. The main factors are the anatomic-functional relationship between muscles innervated by the trigeminal nerve, the middle ear structures, and the TMJ[3,11-12].

Considering auditory symptoms and the occlusal etiology of the TMD, it is important to investigate the auditory health in individuals complaining of associated tinnitus so patients' rehabilitation can

be better provided, whether it is orthodontic- or speech-language pathology and audiology-related.

Thus, this study aims to investigate the auditory health of patients with tinnitus associated with TMD in the pre-dental treatment stage.

Methods

This transversal, descriptive study was performed at Faculdade de Odontologia de Bauru (FOB/USP) and has been approved by the FOB/USP's Research Ethics Committee under protocol No. 114/2006. Participant selection in this study was random, regardless of sex or age. The inclusion criteria were the diagnosis of temporomandibular dysfunction (TMD) and tinnitus complaints.

The participants included in the study were enrolled at the FOB/USP's orthodontic and audiology clinics and were diagnosed by the orthodontics clinic professionals as having TMD.

Exclusion criteria were the presence of a history of central or peripheral neurological disorders, or the presence of tumors or trauma in the head and neck region, as well as previous treatment for TMD and any middle ear alterations.

A total of 53 patients participated in this study. Seven participants were male and 46 female, ranging in age from 22 to 69 years, with a mean age of 41 years.

To investigate the participants' hearing health, they all underwent the following tests:

1. Specific interview containing: identification data, family history, risk indicators for hearing loss, general and auditory health, occupational environment, leisure habits, use of medication, among others. At that time, a questionnaire was applied to collect data concerning tinnitus complaints and the non-auditory effects of noise.
2. Clinical inspection of the external auditory meatus: so that there was nothing preventing specific tests from being performed;
3. Immitanciometry: aiming to verify middle ear conditions and testing for acoustic reflex thresholds by using the GSI TympStar equipment. The study considered as normal those individuals who presented type-A tympanometry curve (according to the Jegger classification[23]) with a maximum peak around zero deca Pascal (daPa) pressure.
4. Conventional pure-tone threshold audiometry (CPTA): testing for auditory thresholds in frequencies 250, 500, 1000, 2000, 3000, 4000, 6000, 8000 Hz for right and left ears. To classify the degree of hearing loss, the authors used the World Health Organization (WHO) degrees of hearing loss (1997)[24], using the mean frequencies of 500, 1000, 2000, and 4000 Hz. Hearing losses were classified as follows: averages from 0 dB to 25 dB. The warble tone was used.
5. Logoaudiometry: the authors tested the speech recognition threshold (SRT) and the percentage speech recognition index (PSRI) through a list of phonetically balanced words;
6. High-frequency pure-tone audiometry (HFPTA): testing for auditory thresholds in frequencies 9000, 10000, 11200, 12500, 14000, and 16000 Hz for right and left ears. The warble tone was used. Pure-tone threshold audiometry (PTA), logoaudiometry, and HFPTA were performed by using the Siemens SD 50 audiometer and HDA 200 headphones.
7. Otoacoustic emissions (OAEs): performed in acoustically treated rooms by using the *Otodynamics, Ltd. ILO 96 Research OAS System* to specifically evaluate the occurrence or non-response. The criterion used for the occurrence of transient otoacoustic emissions (TOAEs) was proposed by Prieve and colleagues (1993) and is considered present when general reproducibility is greater than or equal to 50% with response amplitude in dB greater than or equal to 3 dB SPL in at least three consecutive frequencies assessed. The absence of recording by frequency range was also analyzed in isolation, that is, when there is absence in at least one of them. The testing for TOAEs was performed in frequencies bands 1000, 2000, 3000, and 4000 Hz. The stimulus was nonlinear click type with intensity from 79 to 83 dB and probe stability greater than 80%. Records of distortion-product otoacoustic emissions (DPOAEs) were studied considering the occurrence and amplitude of responses. With two pure tones simultaneously, with different frequencies (f1 and f2), obeying the relation f1/f2 = 1.22; the stimuli intensities obeyed the relation L1=65 dB SPL and L2=55 dB SPL. Responses in frequencies 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz were analyzed. The DP-gram response (DP) 1 (2f1-f2) was considered present when the emission amplitude was 6 dB higher than the noise level (S/N≥6 dB).

Results

The results were analyzed through descriptive methods and shown in tables and graphs. All subjects had tinnitus, which was the inclusion criterion, and that symptom was investigated for laterality, whether it was bilateral or right-sided and left-sided unilateral (Figure 1).

Ear fullness was investigated for presence or absence (Figure 2).

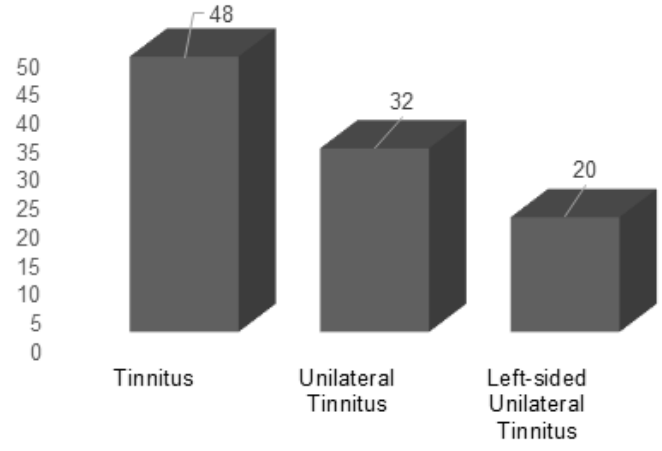

Figure 1. Presence of tinnitus.

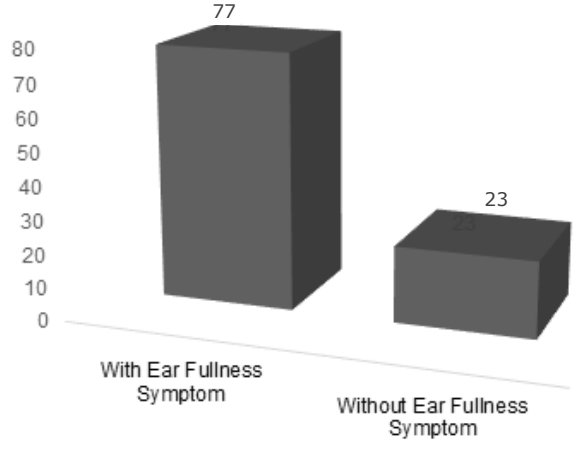

Figure 2. Ear fullness symptom reported by patients.

Otalgia was investigated for presence or absence. When absent, it was classified as bilateral, right-sided unilateral and left-sided unilateral (Figure 3).

By comparing otalgia presence and laterality with tinnitus laterality, the authors found out there is no significant relationship between these data, that is, the side of tinnitus is not related to the side on which there was an otalgia complaint (Figure 4).

TMD laterality was also investigated, and those data were also compared to the tinnitus side. Authors found out that tinnitus is strongly connected to the TMD side, being present in 52 out of 53 participants assessed (98%), which is a very significant data.

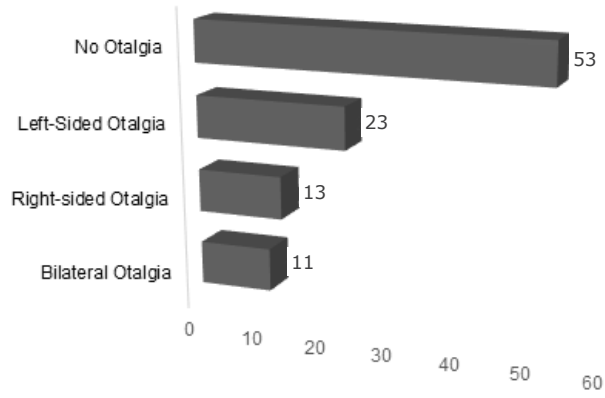

Figure 3. Otalgia symptom reported by patients.

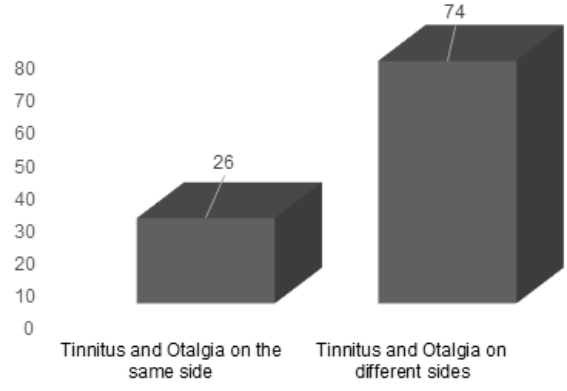

Figure 4. Relationship between tinnitus symptoms and otalgia.

After audiological evaluation through pure-tone threshold audiometry (PTA), high-frequency pure-tone audiometry (HFPTA), immittanciometry with tympanometry, and testing of both acoustic reflex and otoacoustic emissions (OAEs), the 53 participants were distributed as follows: normal hearing, mild loss, moderate loss, and severe loss. Profound loss was not obtained in this particular case. After analyzing both the PTA and the HF-PTA, the researchers found that the latter is more impaired than the first one (Figure 5).

The immitanciometry found 100% type-A tympanometry curve and the presence of acoustic reflex, which shows the middle ear was not compromised during the immittanciometry.

The OAE testing investigated for presence or absence of OAEs in each ear (Figure 6).

That was also investigated in participants who showed absence of OAEs and presence of otalgia, that is, nine participants, which represents 17% of the total sample.

The researchers found out that 98% of the participants had tinnitus on the same side diagnosed with TMD when both were unilateral. When they found bilateral TMD, tinnitus was also bilateral, sometimes more intense on one side. In this case, that may be related to the side where the TMD is more intense but also difficult for the participant to tell apart.

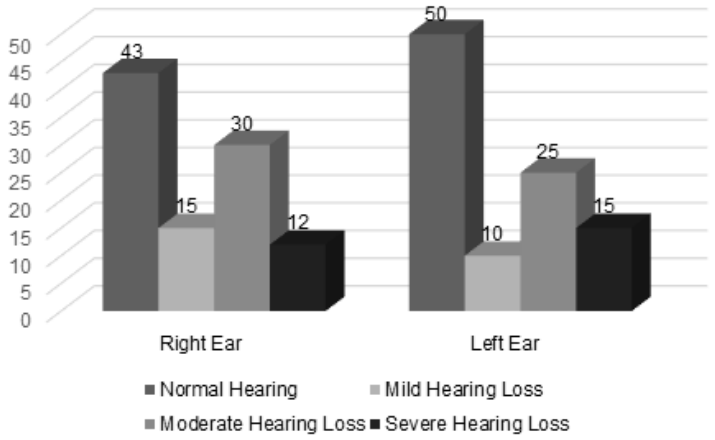

Figure 5. Description of the patient's degree of hearing loss.

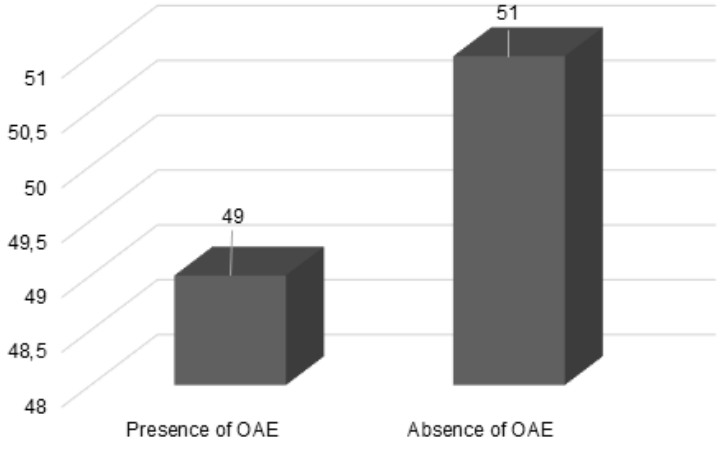

Figure 6. Description of the presence of otoacoustic emissions.

Discussion

The relationship between TMD pain and tinnitus is due to the anatomic proximity between the TMJ and the auditory system, in addition to the trigger points, especially in the sternocleidomastoid and masseter muscles, which cause local and referred pain when stimulated [4]. Thus, the development of algogenic spots in such muscles can refer to the ear and cause tinnitus[11-12].

Tinnitus is defined as an experience in which people hear a noise when there is no corresponding sound stimulus[13]. It is a frequent symptom in individuals with TMD[1]. Recent studies have pointed out that individuals with one or more signs of temporomandibular joint dysfunction, and who have tinnitus complaints and normal hearing in the conventional frequency range, have a high-pitch, continuous, bilateral tinnitus, with a slight impact on the quality of life that affects even the elderly population[11-12].

There was a connection between tinnitus and otalgia since these symptoms occurred on the same side in 74% of the participants (Figure 4). That symptom is also justified by the anatomical proximity since only a thin part of the temporal bone separates the TMJ from both the external acoustic meatus and the middle ear[15]. Participants may confuse that symptom since they often have

difficulty identifying whether the pain is due to the TMD or in the ear[1-2,4].

The TMD multifactorial etiology has been established after many years of study, considering several factors that vary between individuals, and may contribute to the appearance of signs and symptoms related to the stomatognathic system due to changes in normal functions[15-16]. In this sense, gender seemingly plays an important role in the relationship with the TMD since research shows that such change is more common in women, mainly of childbearing age. This is due to the relationship between hormonal levels and increased genetic vulnerability to TMD, which explains the high frequency of TMD in women[17].

Some authors have argued that certain factors are supposed to be more relevant and subdivide them into predisposing factors (which increase the risk of TMD), initiating factors (which lead to the onset of TMD), and perpetuating factors (which interfere in the control of the pathology)[18]. Amongst the most relevant are trauma (direct, indirect, or microtrauma), psychosocial factors (anxiety, depression, among others), and pathophysiological factors (systemic, local, and genetic). However, it is still hard to establish a causal relation between these changes and TMD.

It is known that pain negatively impacts individuals who experience it, affecting social functioning and physical and psychological well-being. TMD considered the main cause of non-dental pain in the orofacial region and negatively affects quality of life[19-20].

A recent study has pointed out the presence of depression and anxiety symptoms in patients with TMD, which suggests the need for psychological counseling along with orthodontic treatment to treat the pain symptom[21].

As to the PTA, no relationship was found between TMD and other otological factors since 94% in the right ear and 88% in the left ear showed normal results in the PTA. The presence of normal hearing corroborates the data already mentioned in other studies[8,11]. The HFPTA showed that 43% in the right ear and 50% in the left ear had thresholds within normality. That information is in agreement with the literature on HFPTA since the results of this procedure are altered earlier than the conventional thresholds in both cochlear and conductive alterations[22].

As to the OAEs, 51% were absent and 49% were absent, indicating the relationship between TMD and otological alterations. That is in agreement with the researched literature. It is important to highlight that the OAE will be absent in patients with altered middle ear[2-23].

In this study, an audiological test battery, such as PTA, Immitanciometry, and HFPTA, showed that the complementary exams (OAEs and HFPTA) were able to show alterations, even minimal, in auditory health, and such data are in agreement with the literature[22-24].

Recent studies have also shown that TMD symptoms, especially pain, can cause a high degree of physical and mental impairment, impacting quality of life in a negative manner[20,25]. The literature also shows that patients with chronic TMD present some degree of pain impact in their lives, especially at work, school, sleep, and appetite/feeding activities presented[26].

Regarding the diagnosis of TMD, there is still no reliable method of diagnosis and measurement for the presence and severity of TMD that can be used unrestrictedly by researchers and clinicians. Despite that, anamnesis is still the most important step for the diagnosis of individual cases during the initial diagnostic impression[9-11]. The process of rehabilitation of patients with TMD associated with tinnitus depends on the appropriate case assessment and involves a multidisciplinary team, which is critically dependent on the speech-language pathologist and audiologist[8-10].

Conclusion

The findings of this study make it clear that the occurrence of auditory alterations in patients with TMD is significant. Also, the results obtained in the audiometric tests suggest that audiological monitoring should be indicated for all patients with TMD, either associated or not with the presence of tinnitus.

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