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Audiological findings in patients with temporomandibular dysfunction

Achados audiológicos em pacientes portadores de disfunção temporomandibular

Thiago Mathias[1], Patrícia Arruda de Souza Alcarás[1,2], Killian Evandro Cristoff[1], Jair Mendes Marques[1], Bianca Simone Zeigelboim[1], Adriana Bender Moreira de Lacerda[1,3]

ABSTRACT

Purpose: To analyze the audiological findings in individuals with temporomandibular disorder and compare these findings with individuals without temporomandibular disorder. **Methods:** The sample was composed by 39 adult participants, both genders, with previous diagnosis of temporomandibular disorder (study group) and 39 adult participants, without temporomandibular disorder (control group). All the participants were submitted to audiometry including high frequencies, Immittance acoustic (Tympanometry and contralateral acoustic reflexes) and distortion product evoked otoacoustic emissions. **Results:** The prevalence of temporomandibular disorder on female gender was observed, average age was over forty years old. In the audiometry, it was observed the incidence of hearing loss of a sensorineural and conductive type in the Study Group, besides worst hearing thresholds in high frequencies. In both groups, there was a bigger incidence of a type A tympanometric curve, as well as there were differences between the groups in the research of the ipsilateral and contralateral acoustic reflex and in the recording of distortion product evoked otoacoustic emissions. **Conclusion:** It's possible to conclude that individuals with temporomandibular disorder show worst results in the hearing thresholds, in the tympanometry, in the ipsilateral and contralateral acoustic reflexes, in the evoked otoacoustic emissions, when compared to the control group.

Keywords: Hearing tests; Temporomandibular articulation; Articulation disorders; Hearing; Hearing loss

RESUMO

Objetivo: Analisar os achados audiológicos em indivíduos com desordem temporomadibular e comparar esses achados com indivíduos sem desordem temporomanbibular. **Métodos:** A amostra foi composta por 39 participantes adultos, de ambos os gêneros, com diagnóstico prévio de desordem temporomandibular (grupo de estudo) e 39 participantes adultos, sem desordem temporomandibular (grupo controle). Todos os participantes foram submetidos à audiometria tonal limiar em altas frequências, imitanciometria e pesquisa das emissões otoacústicas evocadas por produto de distorção. **Resultados:** Observou-se prevalência de desordem temporomandibular no gênero feminino e a média de idade ficou acima da quarta década de vida. Na audiometria tonal limiar, foi observada ocorrência de perda auditiva do tipo neurossensorial e condutiva, no grupo de estudo, além de piores limiares auditivos em altas frequências. Em ambos os grupos, houve maior ocorrência de curva timpanométrica do tipo A, bem como diferenças entre os grupos na pesquisa do reflexo acústico ipsilateral e contralateral e no registro das emissões otoacústicas evocadas por produto de distorção. **Conclusão:** Indivíduos com desordem temporomandibular apresentam piores resultados nos limiares auditivos, na timpanometria, nos reflexos acústicos ipsilaterais e contralaterais e nas emissões otoacústicas evocadas, quando comparados com o grupo controle.

Palavras-chave: Testes auditivos; Articulação temporomandibular; Transtornos da articulação; Audição; Perda auditiva

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[1]Universidade Tuiuti do Paraná – UTP – Curitiba (PR), Brasil.
[2]Universidade do Oeste Paulista – UNOESTE – Presidente Prudente (SP), Brasil.
[3]Université de Montréal - UdeM – Montréal (Qc), Canada.
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Corresponding author: Adriana Bender Moreira de Lacerda. E-mail: adriana.lacerda@utp.br
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INTRODUCTION

Temporomandibular disorder (TMD) is a syndrome entailing heterogeneous symptoms of odontological and neurological scope and recognized as Costen's Syndrome[1,2].

American Academy of Orofacial Pain defined TMD as clinical conditions affecting chewing muscles, temporomandibular joint (TMJ) and related structures[3], which may generate several clinical symptoms on the individuals, limitations in the mandibular motion, uncoordinated motion, joint noise and pain[4].

Individuals with TMD may also present hearing and vestibular symptoms, such as tinnitus, vertigo, dizziness, hypoacusis, ear fullness, hyperacusis and muffled hearing[5,6]. Nevertheless, there has not yet been agreement on the origin of such symptoms.

Epidemiological findings showed that otological symptoms may range from 10% to 31%, increasing to 85% in patients with TMD[7], being females more affected by the disorder between forty and fifty years of age[6,8,9]. That correlation is certainly due to a close anatomic link between the structures, but also by the trigeminal inversion[10].

A broad range of results among the studies prevents the establishment of symptom prevalence in the TMD. Moreover, that occurrence does not necessarily imply a cause-effect relationship. Probable association must be investigated by the involved professionals[11-14].

The current study aimed to analyze audiological findings in individuals with temporomandibular disorder and compare those findings to individuals without temporomandibular disorder.

METHODS

This research was carried out at a Speech-Language Teaching Clinic of a university and approved by the Research Ethics Board of Universidade Tuiuti do Paraná, Brazil Platform, number 1.180.334, and Certificate of Presentation for Ethical Consideration (Certificado de Apresentação para Apreciação Ética - CAAE) 47657114.7.0000.0103. All ethical procedures in research were adopted according to Resolution 466/12 of the Brazilian National Health Council (Conselho Nacional de Saúde – CNS), and all participants were included after signing the Free Informed Consent Form.

The sample comprised adult participants, both genders, with or without previous TMD diagnosis (study and control groups, respectively). Excluded participants from the study group had clinical history of hearing and vestibular disorders (hearing disorders prior to TMD), occupational diseases (exposure to hearing-risk agents), and individuals making use of medication for treating TMD-related pain and/or inflammation. Excluded participants from the control group were diagnosed with hearing and vestibular disorders related to their clinical history (prior diseases), as well as temporomandibular joint complaints or TMD diagnosis.

The selected participants for the study group presented prior TMD diagnosis, being followed up at the Dentistry teaching clinic, and for the control group, companions of patients treated at the Speech, Language Teaching Clinic of the same university were selected. Subjects from both groups were contacted to participate in the study by phone.

Thus, the sample entailed 78 participants, 39 male and female adults (study group – SG), with previous diagnosis of TMD, and 39 male and female adults without TMD diagnosis or prior history of mandibular disorders (control group – CG). The groups were paired according to gender and age. Gender and age prevalence was determined by the study group.

All participants underwent audiological screening. Previously, assessment of the outer acoustic meatus was carried out in order to verify the conditions of the outer ear and tympanic membrane. Subsequently, tonal threshold audiometry (250 to 8000 Hz) was held as well as high frequencies (9000 to 16000 Hz), by means of Itera II audiometer, participants in an acoustically treated booth. Regarding hearing loss degree, results were rated according to Lloyd and Kaplan (1978), and as for the type of hearing loss and configuration, Silman and Silverman (1997) ratings were applied[15].

Tympanometry and screening of the stapedius muscle acoustic reflex were performed by means of Otoflex tympanometer. Tympanometric curve was obtained with probe tone of 226Hz, and acoustic reflex was assessed in ipsilateral and contralateral modes, at 500, 1000, 2000 and 4000 Hz frequencies, intensities ranging from 70 to 110 dB. Tympanometric curves were classified according to Jerger classification (1970), and Gelfand classification (1984), and Jerger & Jerger (1989) were adopted to classify the findings in the acoustic reflex, as recommended[15]. The acoustic reflex, contralateral mode, was classified as normal when the difference between the behavioral threshold (airways) and the acoustic reflex was between 70 and 100 dB, decreased when the difference between the behavioral threshold and the acoustic reflex was below 70 dB, increased when the difference between the behavioral threshold and the acoustic reflex was higher than 100 dB, and absent when the reflex was not triggered in the maximum intensity of the equipment (110 dB)[15].

Some participants did not go under tympanometry and acoustic reflex assessment because the immittance meter was not available for use at the moment of the testing.

After the tonal audiometry and acoustic immittance screening, distortion product otoacoustic emissions (DPOAE) were performed. For the DPOAE recording, participants featuring normal tympane-bone system and audiometric thresholds up to 45 dBNA were included.

Madsen Celesta was the equipment used to record the evoked otoacoustic emissions (EOAE), stored in a microcomputer, with the participants inside an acoustically treated booth.

DPOAE were performed by means of the *Distortion Product-gram* (Dp-gram), featuring two symultaneous primary tones, f1 and f2 (f1 < f2). Thus, the f2/f1 ratio of 1.22 was used, with primary tones at different levels (L1 > L2) - L1 = 65 dBSPL and L2 = 55 dBSPL. Dp-gram was recorded at three points/octave steps, and plotted at f2, frequency range extending from 1000 Hz to 8000 Hz. The response recording used was obtained at 2f1-f2. The criterion used to report the occurrence of DPOAE was with response level at least 6 dBSPL above the first standard deviation equivalent to the assessed frequency[16].

Study participants featuring hearing disorders in any testing, were advised to see an otorhinolaryngologist to investigate their etiology.

Statistical analyses were carried out by means of descriptive and inferential Statistics (Student's T-test, Fischer's exact test and Chi-square test), significance level of 0.05%. Ears were intentionally analyzed separately, once TMD may occur unilaterally or bilaterally, and lateral disorder may be related to the result of the hearing assessment[2,4].

The analyzed variables were audiometric thresholds, tympanometric curves, ipsilateral acoustic reflex, contralateral acoustic reflex (normal, decreased, increased or absent), and the presence or absence of DPOAE per frequency range.

RESULTS

The sample comprised 78 adult subjects, the groups were paired by age and gender, and both groups had ages ranging from 22 to 74 years (mean=50.19, SD= 14.62), no difference between the ages (p=1.000). Each group entailed 36 (92.31%) female participants, and 3 (7.69%) male participants. Female participants, with previous diagnosis of TMD, were majority, and they seemed to have higher time availability to go to the Speech Language Clinic for hearing assessment when invited to participate in the study.

In the study group, findings of the tonal threshold audiometry and high frequencies reported worse tonal thresholds at frequencies of 250 (p=0.0002), 500 (p=0.0029), 8000 (p=0.0064) and 14000 Hz (p=0.0110) in the left ear, with significantly worse results in the Student's T-test, significance level of 0.05% (Figure 1).

In the audiometric profile, sensorineural and conductive hearing losses were observed in both ears in the study group, higher evidence for mild hearing loss and descending audiometric configuration (Table 1).

Imitanciometry screening found higher occurrence of type A tympanometric curve in both groups. However, it was observed the presence of type Ad, As and B tympanometric curves in the study group (Table 2).

Concerning the acoustic reflex of the stapedius muscle by ipsilateral stimulation, it was observed difference in the intensity to trigger the reflex threshold, in both groups, being

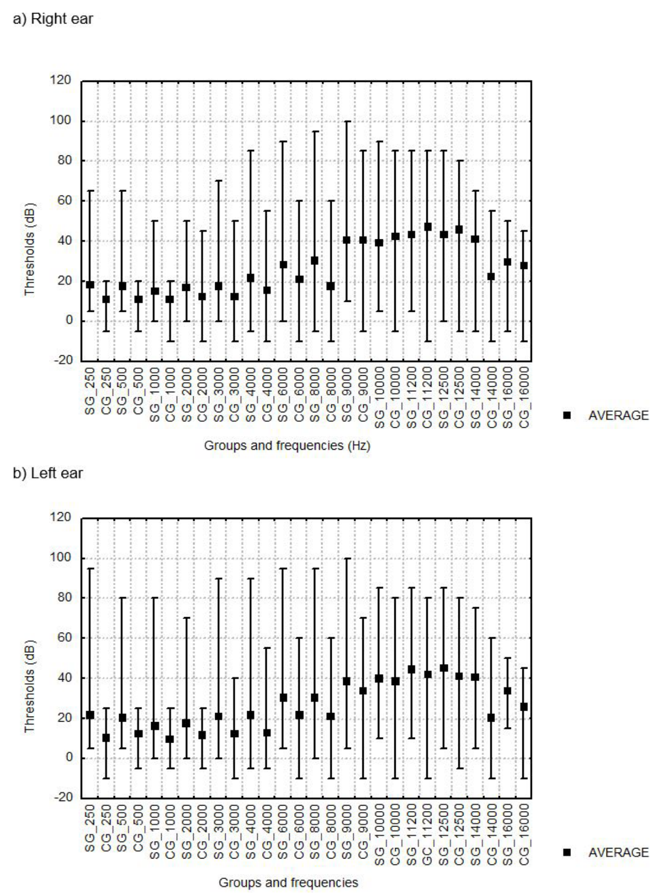

Figure 1. Mean, minimum and maximum values of the tonal thresholds at conventional and high frequencies in the study and control groups – right ear and left ear
Legend: dB = decibel; Hz = hertz; SG = study group; CG = control group

Table 1. Audiometric profile of the study group (n=39) and control group (n=39)

CHARACTERISTICS	*STUDY GROUP*				*CONTROL GROUP*			
	RE		LE		RE		LE	
Type of loss	n	%	n	%	n	%	n	%
Conductive	02	05.13	02	05.13	--	0.00	--	0.00
Sensorineural	08	20.51	07	17.95	--	0.00	--	0.00
Normal	29	74.36	29	74.36	33	84.62	35	89.74
Restricted loss at 6 and/or 8 kHz	---	0.00	01	02.56	06	15.38	04	10.26
Degree of loss								
Mild	08	20.51	02	5.13	06	15.38	--	0.00
Moderate	01	02.56	--	0.00	02	25.13	--	0.00
Moderate/severe	01	02.56	--	0.00	02	05.13	--	0.00
Normal	29	74.36	37	94.87	29	74.36	39	100
Configuration								
Ascending	01	02.56	--	0.00	01	02.56	--	0.00
Descending	07	17.95	02	05.13	08	20.51	--	0.00
Flat	02	05.13	--	0.00	01	2.56	--	0.00
Normal	29	74.36	37	94.87	29	4.36	39	100

Subtitle: LE = left ear; RE = right ear; n = number of participants; % = percentage higher in the control group, by ipsilateral stimulation of the right afferent at the frequency of 4000 Hz (p=0.0017), and of the left afferent at frequencies of 2000 Hz (p=0.0029) and 4000 Hz (p=0.0000) (Figure 2).

The acoustic reflex of the stapedius muscle by contralateral stimulation was rated as normal, decreased, increased or absent. There was significant difference in the contralateral acoustic reflex at 500 Hz, bilaterally, (p=0.0129, right ear, and p=0.0077, left ear), and at 4000 Hz in the right ear (p=0.0171) (Table 3/Figure 3).

When compared to the contralateral acoustic reflex between study and control groups, concerning normal and altered rating (decreased and increased), significant difference was observed (Chi-square test at significance level of 0.05) at frequencies of 500 Hz (p=0.0458) and 1000 Hz (p=0.0094), both in the right ear. In this analysis, normal rating prevailed for the control group and altered (contralateral decreased or increased acoustic reflex) for the study group (Table 4).

As for the DPOAE results, it was observed in the left ear, at the frequency of 6000 Hz, greater occurrence of absence in the study group in relation to the control group, being a statistically significant result (Table 5).

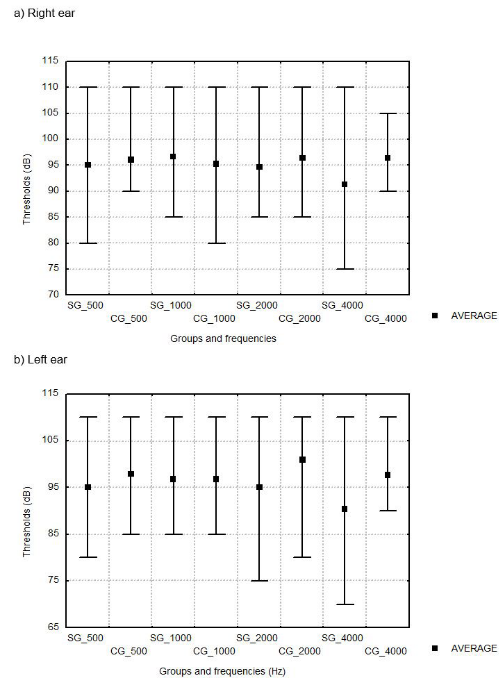

Figure 2. Findings of the ipsilateral acoustic reflex in the study and control groups – right ear and left ear
Subtitle: dB = decibel; Hz = hertz; SG = study group; CG = control group

Table 2. Types of tympanometric curves separated by the study group (n=39) and control group (n=39)

TYPES OF CURVES	***STUDY GROUP***				***CONTROL GROUP***			
	RE		**LE**		**RE**		**LE**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
A	29	74.4	28	71.8	37	94.9	37	94.9
AD	2	5.1	2	5.1	-	0.0	-	0.0
AS	2	5.1	3	7.7	-	0.0	-	0.0
B	1	2.6	1	2.6	-	0.0	-	0.0
Not performed	5	12.8	5	12.8	2	5.1	2	5.1

Subtitle: LE = left ear; RE = right ear; n = number of participants; % = percentage

Table 3. Comparison of the contralateral acoustic reflex between the study group and control group

FREQUÊNCY –EAR	**GROUPS**	**REFLEXO ACÚSTICO CONTRALATERAL**				**P Value**
		Absent	**Decreased**	**Increased**	**Normal**	
		n	**n**	**N**	**n**	
500 Hz – RE	SG	9	5	5	16	*0.0129
	CG	-	6	-	31	
500 Hz – LE	SG	11	1	4	19	*0.0077
	CG	-	8	-	29	
1000 Hz – RE	SG	9	7	3	16	NA
	CG	-	4	-	33	
1000 Hz – LE	SG	12	7	1	15	0.8942
	CG	-	9	2	26	
2000 Hz – RE	SG	9	5	3	18	0.6115
	CG	-	4	3	30	
2000 Hz – LE	SG	14	4	3	14	0.9166
	CG	-	7	4	26	
4000 Hz – RE	SG	14	2	8	11	*0.0171
	CG	-	10	3	24	
4000 Hz – LE	SG	15	5	4	11	0.2824
	CG	-	17	6	13	

*Statistically significant values ($p \leq 0.05$) – Fisher's ExactTest
Subtitle: n = number of participants; Hz = Hertz; LE = left ear; RE = right ear; SG = study group; CG = control group; NA = not applied (due to the reduced number of participants)

Table 4. Comparison of the contralateral acoustic reflex between the study group and the control group, due to the normal and altered classification (increased or decreased)

FREQUÊNCY EAR	GROUP	CONTRALATERAL ACOUSTIC REFLEX		P Value
		Altered	Normal	
500 Hz – RE	SG	10	16	*0.0458
	CG	6	31	
500 Hz – LE	SG	5	19	0.9415
	CG	8	29	
1000 Hz – RE	SG	10	16	*0.0094
	CG	4	33	
1000 Hz – LE	SG	8	15	0.6825
	CG	11	26	
2000 Hz – RE	SG	8	18	0.2769
	CG	7	30	
2000 Hz – LE	SG	7	14	0.7756
	CG	11	26	
4000 Hz – RE	SG	10	11	0.3503
	CG	13	24	
4000 Hz – LE	SG	9	11	0.1711
	CG	23	13	

*Statistically significant values ($p \leq 0.05$) – Chi-square Test.
Subtitle: Hz= Hertz; LE = left ear; RE = right ear; SG= study group; CG = control group

Table 5. Comparison between the study group and the control group in the presence and absence of product distortion evoked otoacoustic emissions – signal/noise relation

FREQUENCY AND EAR	*STUDY GROUP*						*CONTROL GROUP*						P Value
	Absent		Present		No response		Absent		Present		No response		
	n	%	n	%	N	%	n	%	n	%	n	%	
RE 1000 Hz	1	2.56	25	64.10	13	3.33	-	0.00	30	76.92	9	23.08	0.4643
RE 2000 Hz	3	7.69	23	58.97	13	3.33	-	0.00	30	76.92	9	23.08	0.0938
RE 3000 Hz	3	7.69	23	58.97	13	33.33	-	0.00	30	76.92	9	23.08	0.0938
RE 4000 Hz	2	5.13	24	61.54	13	33.33	-	0.00	30	76.92	9	23.08	0.2110
RE 6000 Hz	6	15.38	20	51.28	13	33.33	2	5.13	28	71.79	9	23.08	0.0855
RE 8000 Hz	6	15.38	20	51.28	13	33.33	6	15.38	24	61.54	9	23.08	0.5167
LE 1000 Hz	2	5.13	25	64.10	12	30.77	-	0.00	30	76.92	9	23.08	0.2199
LE 2000 Hz	2	5.13	25	64.10	12	30.77	-	0.00	30	76.92	9	23.08	0.2199
LE 3000 Hz	3	7.69	24	61.54	12	30.77	-	0.00	30	76.92	9	23.08	1.0000
LE 4000 Hz	3	7.69	24	61.54	12	30.77	-	0.00	30	76.92	9	23.08	1.0000
LE 6000 Hz	8	20.51	19	48.72	12	30.77	-	0.00	30	76.92	9	23.08	*0.0013
LE 8000 Hz	8	20.51	19	48.72	12	30.77	7	17.95	23	58.97	9	23.08	0.4054

* = significant difference
Subtitle: LE = left ear; RE = right ear; Hz = Hertz; n = number of participants

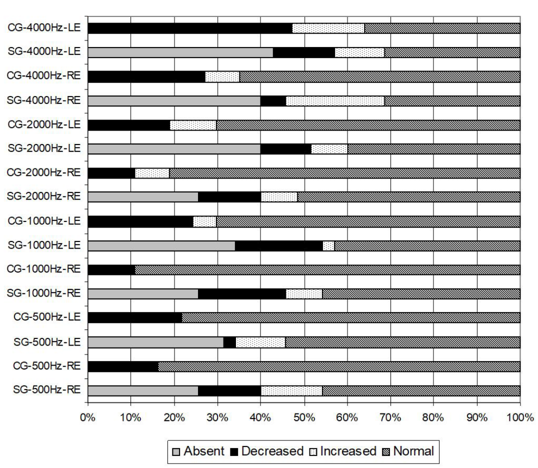

Figure 3. Comparison of the contralateral acoustic reflex between the study group and control group due to the absent, decreased, increased and normal classification – right ear and left ear
Subtitle: RE = right ear; LE = left ear; Hz = hertz; SG = study group; CG = control group

DISCUSSION

This study comprises an adult sample from both genders. Greater occurrence of TMD was observed among females, average age over forty years old. Such findings corroborate studies which pointed signs and symptoms for TMD prevalent in female subjects between forty and fifty years of age. This fact could be related to the greater frequency of women to health care services, enabling the TMD diagnosis[6,8,9,17].

Regarding the audiometric findings, greater occurrence of normal hearing was observed in both groups. However, only in the study group, sensorineural and conductive hearing loss was verified, with worse hearing threshold at certain frequencies. Other studies[18-20] also evidenced alterations in the audiometric thresholds, in research with TMD patients, and verified worse hearing thresholds at high frequencies. Authors[18], at the end of the metanalysis, described, among other findings, the correlation between TMD and hearing loss (32.7%).

Therefore, high-frequency audiometry has been used, mainly to identify early hearing loss. Studies have not agreed on the calibration patterns and normality, on the equipment limitations and applied methodology. However, there is agreement about the necessary care while carrying out the testing and the subject's age in high- frequency auditory thresholds. Factors, such as the type of transduct or individuals' position may cause distortions which raise doubtful responses[21,22]. This fact could explain why a statistical difference between the groups was evidenced only at the frequency of 14000 Hz. Thus, it is clear the need for further studies on the matter.

It should be considered that, in both groups, most participants were adults, mean age in their fifties, however, many have reached the sixties and seventies, and could be prone to age-related hearing loss. This fact justifies the possibility to coexist related hearing impairments, and raises the need to define the audiological conditions of individuals with TMD[19]. Concerning conductive hearing loss, it could be related to the close anatomic connection between the temporomandibular joint structures and the auditory system, and also to the trigeminal inversion[8].

The study[23] which assessed the effectiveness of the TMD treatment in 122 patients with hearing complaints, showed that most of them featured normal hearing, with air-bone gap ≤ 5 dB, and airway threshold ≤25 dB, and 22 patients presented unilateral or bilateral hearing loss at 4-8 kHz (30-70 dB threshold).

Authors[10] verified that the prevalence of altered screening, in relation to normal one, was insignificant. However, the signs and symptoms associated with the TMD and octalgia were correlated. Therefore, they concluded that the most frequent symptoms were joint sounds, tinnitus and ear fullness.

In the tympanometric results, it was observed that the majority presented A-type tympanometric curve, but only the participants in the study group featured Type-Ad, As and B curves.

An author[24] confirmed that the incidence of middle-ear disorders is unlikely, as, in his study, all patients with TMD kept A-type tympanometric curves, matching the findings of the current study.

According to an author[25], TMJ and ear structures evolve, embryologically, from the same fissure (Meckel cartilage). Anatomically, TMJ is close to the external acoustic meatus (EAM), and structures are correlated to its vascular, arterial and innervation parts. Thus, in case of any physiological or oclusal disorders, a displacement may occur, harming their surrounding anatomic components, causing a great number of consequences.

Research[26] pointed that the jaw condyle, when displaced, may cause the stretching of the ossicular chain, thus occurring otological symptoms. Another hypothesis would be the occurrence of chewing muscles hyperactivity, which would, in turn, lead to the contraction of the tympane tensor muscle as well as the tympanic membrane, or to the muscle contraction of the soft palate. This fact may cause the Eustachian tube dysfunction, and subsequently, symptoms of ear fullness, imbalance and hearing loss[10,19,26].

As for the ipsilateral stimulation of the acoustic reflex, difference in intensity to trigger the reflex threshold was observed in both groups, higher in the control group. In the current study, research of the acoustic reflex by contralateral stimulation showed significant difference between the groups at certain frequencies. The study group evidenced prevalence of altered acoustic reflex (decreased or increased) when compared to the control group.

Authors[19,20] reported, in their studies, that ipsilateral and contralateral acoustic reflexes were present and did not point to the existence of recruitment. However, the participants of the studies[19,20] featured younger age range and better audiometric thresholds when compared to the current study.

The retrospective study[27] comprised 30 patients with diagnosed dentofacial deformities and TMD, males and females, between 18 and 49 years of age, undergoing clinical assessment (muscle palpation, temporomandibular joint auscultation during the mandibular motions and measurement of mandibular motion), audiological testing (audiometric tonal threshold and imitanciometry) and two questionnaires, being one on otological and vestibular symptoms and other related to the TMD. Results evidenced absence of disorders in the audiological and imitanciometric testing to all the assessed subjects. The findings of ipsilateral and contralateral acoustic reflexes were present in this population, intensity values below 115 dBNA.

In the DPOAE, although there are significant differences between the groups at the frequency of 6000 Hz, most responses were present in the study participants.

The study which performed otoacoustic emissions in the populations with TMD, used the protocol of transient evoked otoacoustic emissions (TEOE), however, only individuals with normal audiometric thresholds[28] were included in the analyses of the study. In the current study, for the analyses of the otoacoustic emissions, participants with audiometric thresholds up to 45dBNA were included, thus, the DPOAE were used, once literature evidences the possibility to record DPOAE in individuals with hearing thresholds between 45-55 dBNA, however, with lower amplitudes, comparing with individuals presenting normal audiometric thresholds[29]. Moreover, it is not possible to determine the hearing threshold for each frequency by means of the DPOAE presence or amplitude, only demonstrate the functionality of the outer hair cells[29].

By analyzing the results of the transient otoacoustic emissions (TOAE) from the absence of recording by frequency range, considering the total number of analyzed ears, authors[28] verified that the percentage of ears with absent responses was similar between participants with and without TMD, not being able to state that the participants with TMD had featured cochlear disorders, unlike what was found in the current study, as the occurrence of participants with absent response at the frequency of 6000 Hz, in the left ear, was higher in the study group in comparison to the control group.

Thus, the data in the current study enable to draw some conclusions about the subject: 1) it is possible for individuals with TMD to feature disorders in auditory findings, mainly in the audiometry (conventional and high frequency), and in the imitanciometry; 2) considering the study criteria, the EOAE would not be a sensitive instrument to assess individuals with TMD; 3) longitudinal studies to determine audiological profile are recommended, considering gender, age range and TMD conditions and clinical manifestations; 4) the suppression of the otoacoustic emissions could have been carried out to assess the efferent cochlear system.

This study showed some limitations due to the reduced number of participants: 1) it was not possible to correct the auditory findings with the TMD conditions and clinical manifestations (causal factors, signs and symptoms, laterality, among others); 2) it was not possible to analyze the results of the hearing assessment in relation to gender and age range.

Carrying out further studies to characterize the audiological profile of individuals suffering from temporomandibular dysfunction is pertinent, once the TMD diagnosis is still controversial, as well as the relation of the dysfunction to hearing findings.

CONCLUSION

Individuals with temporomandibular joint disorder, when compared to the control group, feature worse results in the auditory thresholds in the tympanometry, in the ipsilateral and contralateral acoustic reflexes and in the evoked otoacoustic emissions.

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