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Correlation between speech perception and tinnitus before and after the use of hearing aids

Correlação entre percepção de fala e zumbido antes e após o uso de amplificação

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ABSTRACT

Purpose: To assess the degree of annoyance of tinnitus through the Tinnitus Handicap Inventory (THI) and correlate it with the perception of speech using the Hearing in Noise Test (HINT) before and after the fitting of a hearing aid (HA). **Methods:** There were 27 patients with bilateral sensorineural hearing loss, continuous bilateral tinnitus (minimum six months) without experience of amplification. The subjects answered the anamnesis, the THI questionnaire, underwent a HINT, were fitted with hearing aids, and were again evaluated after three months. The results were statistically analyzed. **Results:** Pre and post THI adaptation of hearing aids indicated benefits from amplification in relation to decreased sensation of tinnitus. The pre and post HINT adaptation of hearing aids presented a significant difference. There were differences in the correlation between the THI and HINT before the fitting of the hearing aids. **Conclusion:** There was an improvement in the degree of tinnitus annoyance after the fitting of the hearing aids. There was no significant correlation between speech perception before and after the use of hearing aids.

Keywords: Tinnitus; Hearing loss; Hearing aid; Speech perception; Adult

Clinical trials: 394

RESUMO

Objetivo: Avaliar o grau de incômodo do zumbido, por meio do questionário *Tinnitus Handicap Inventory* (THI) e correlacionar com a percepção da fala, utilizando o *Hearing in Noise Test* (HINT), antes e após adaptação de Aparelho de Amplificação Sonora Individual (AASI). **Métodos:** Participaram da pesquisa 27 indivíduos com perda auditiva sensorioneural bilateral, zumbido bilateral contínuo (no mínimo, seis meses) e sem experiência prévia com amplificação. Os indivíduos responderam a anamnese, ao questionário THI e realizaram o HINT, foram adaptados com AASI e, após três meses, realizaram novamente as avaliações. Os resultados foram submetidos à análise estatística. **Resultados:** O THI pré e pós-adaptação de AASI indicou benefício com amplificação em relação à diminuição da sensação do zumbido. O HINT pré e pós-adaptação de AASI não obteve diferença significativa. Houve diferença na correlação do THI e HINT antes da adaptação do AASI. **Conclusão:** Houve melhora em relação ao grau de incômodo do zumbido, após a adaptação do AASI. Não houve correlação significativa entre a percepção de fala, antes e após a utilização do AASI.

Descritores: Zumbido; Perda auditiva; Auxiliares de audição; Percepção da fala; Adulto

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INTRODUCTION

Hearing loss is defined as decreased hearing in any degree that reduces the intelligibility of the spoken message regarding interpretation or learning[1].

One way to lessen the impact of hearing loss in a person is the use of hearing aids (HA)[2] which is also a therapeutic tool in the audiological maintenance of tinnitus[3,4].

Tinnitus is considered a perception of sound without its presence in the environment. It consists of a sense defined as illusory, which can be characterized as noise like the sound of rain, sea, running water, bells, insects, whistling, squeaking, doorbells, pulsation and others. This feeling can be continuous or intermittent, have different tonal characteristics, be intense or mild and is perceived in the ears or head[5].

In an epidemiological study conducted in São Paulo in 1960, individuals over 18 years of age answered a questionnaire related to tinnitus. The symptom was observed in 22% of the sample, with a higher prevalence in females, increasing significantly with age, producing severe discomfort in 34% of the group[6].

It can be said that tinnitus is commonly associated with acoustic trauma, ear disease, head and neck trauma, cardiovascular, metabolic, neurological, psychiatric disorders, dental factors, side effects of ototoxic drugs, caffeine abuse, nicotine and alcohol[5,7]. It is also associated with hearing loss, and 78% to 90% of patients with tinnitus have changes in audiometric thresholds[7].

The questionnaire called the Tinnitus Handicap Inventory (THI) evaluates the emotional, functional and catastrophic tinnitus aspects and has been broadly used in the clinical setting to assess patients with this symptom for the quantification of nuisance and analysis of responses to proposed treatments[8].

Research has shown that individuals with hearing loss associated with tinnitus benefit with the use of hearing aids because the device promotes the understanding of speech and relieves tinnitus. Thus, the authors recommend the adaptation of hearing aids in patients with hearing loss accompanied by tinnitus as an alternative to intervention[2,3,9].

Many times speech perception is associated with tinnitus and may be harmed by this symptom. This combination can lead to significant changes in the individual's communication and, consequently, in their quality of life[10].

Given that the main goal of amplification is to restore the intelligibility of speech, it is very important to realize that perception tests speaks to evaluate the performance of hearing aids, especially in noisy conditions since they simulate more real situations[11].

To better assess the individual's performance in noise, speech perception tests, such as the Hearing in Noise Test (HINT) have been used in some research centers in Brazil[12]. There are indications for deficit in speech recognition in individuals with tinnitus, regardless of any other associated auditory perception[13].

In view of this, and considering that tinnitus is, in most cases, a debilitating problem[7] which may lead the carrier to attempt suicide[14], the importance of research for this symptom is emphasized.

The present study arose from the interest in helping patients seeking intervention for hearing loss associated with tinnitus. Thus, it aims to assess the degree of tinnitus annoyance and speech perception before and after intervention with the use of hearing aids.

METHODS

Interventional study including clinical trials developed after approval by the Ethics Committee of the Bauru Dental School, *Universidade de* São Paulo (USP), under protocol 21127813.7.0000.5417.

Sample

The sample was selected according to the following inclusion criteria:

- Diagnosis of symmetrical, bilateral and sensorineural hearing loss, mild to moderate;
- Age over 18;
- Complaint of continuous bilateral tinnitus for at least 6 months;
- Previous experience of absence with amplification.

Exclusion criteria included were:

- Hearing loss and / or unilateral tinnitus;
- Complains of occasional tinnitus;
- Cognitive and / or motor inability for hearing aid fitting.

Procedures

First, the subjects responded to the clinical history, which includes specific data on hearing complaints and difficulties in speech comprehension in noise. Hearing loss classification was based on audiometric thresholds at 500, 1000, 2000 and 4000 Hz, characterized as mild hearing loss (average 26-40 dB HL), moderate (average 41-60 dB HL), severe (average 61-80 dB HL) and deep (average above 81 dB HL).

To evaluate the annoyance caused by tinnitus, the survey participants answered the THI instrument (Tinnitus Handicap Inventory) on two occasions: first, at the beginning of the study and second, after three months of the use of hearing aids.

The THI questionnaire was translated and validated for Brazilian Portuguese[15] consisting of 25 questions, divided into three scales. The functional range (F) measures the nuisance caused by tinnitus in mental, social, occupational and physical functions. The emotional scale (E) measures the affective responses, such as anxiety, anger and depression. The catastrophic (C) quantifies despair and disability reported by those affected to live or get rid of the symptom. There are three

response options for each of the questions, scored as follows: yes answers (4 points), sometimes (2 points) and not (no points).

Responses were scored from zero - when the tinnitus does not interfere in the life of the patient - up to 100 (points or %) - when the level of discomfort was severe. The sum of the resulting points of the question answers were categorized into five groups or degrees of severity:
Grade 1: negligible (0% -16%);
Grade 2: mild (18% -36%);
Grade 3: moderate (38% -56%);
Grade 4: severe (58% -76%);
Grade 5: catastrophic (78% -100%).

To assess the speech perception of the subjects, the HINT (Hearing in Noise Test) was performed, adapted to Brazilian Portuguese[12]. The HINT is an adaptive test which requested the individual`s recognition and repetition of simple sentences in quiet and in noise.

This test was also performed on two occasions: at baseline and after three months of the use of hearing aids, always in an acoustically treated room, allowing adequate participant positioning for the evaluator and the equipment, and the sentences were presented in free field.

For the presentation of the stimuli, the up-down strategy, which allows the determination of the speech recognition threshold necessary for the subject to identify 50% of speech stimuli in the established signal/noise (S/N) was used. This equivalent value is set by the HINT´s own protocol and has two phases: the first involves the first four sentences and intensities the range from 4 dB in 4 dB. This stage estimates the threshold of the subject. The second starts from the fifth sentence, with intensities ranging from 2 dB in 2 dB and enable the determination of the threshold with higher accuracy.

The stimulus speech was presented frontally and initially without background noise. Then the signal was presented with frontal noise, with noise on the right side and noise on the left. The noise was kept at 65 dB and the signal strength was adjusted more or less according to the participant's response.

It is noteworthy that the HINT equipment provides a standardized nomenclature of the four test conditions. When a correct answer is obtained, the S/N ratio is decreased by an equivalent amount. When the answer is incorrect, the S/N ratio is increased by the same equivalent. For example, an S/N ratio of -5 dB indicates that the sentences were presented to 60 dB (or 5 dB below the noise of 65 dB), to correctly repeat 50% of the sentences.

The sign is represented by a list of sentences and the noise used is the sentences of the material itself. An S/N negative ratio indicates greater difficulty in testing and better performance of the subject. The more negative the relationship, the greater the difficulty, since the signal was being emitted below the noise intensity.

In the situation in free field, the speech reception threshold is obtained by applying 20 recorded sentences, which simulate the four conditions described below:

1. Silence (S): the sign out in front of the individual in a noiseless test condition (0° azimuth).

2. Noise Front (NF): the signal and noise are placed directly in front of the individual in a noise condition 0º azimuth.

3. Noise Right (NR): the signal is positioned ahead of the individual and the noise is emitted at 90° to the right of the individual (noise condition right - noise 90° azimuth).

4. Noise Left (NL): the signal is positioned ahead of the individual and the noise is emitted 90^0 on the left (noise condition left - noise at 270° azimuth).

Regardless of the manner of application of the HINT, the software itself prepares for the situation with ear and open field phones called Noise Composite (NC), which is the weighted average of the four conditions as follows: NC = (2* NL + NF + NR) / 4.

HA selection

After completion of the HINT, the subjects were referred for the selection and fitting of hearing aids. Audiological features and communicative needs of the participants were analyzed and the HA Una™ M AZ (Phonak®, Stafa, Switzerland) was selected, indicated for mild to moderate hearing loss.

After the programming of the hearing aids, the verification procedure with a measures probe microphone was carried out. Values with Real-Ear Aided Response (REAR) were compared to targets of prescriptive rule NAL-NL1 for weak, medium and strong sounds. Equivalent responses were considered when the difference between the target set to REAR and the real ear obtained value does not exceed 10 dB[16]. For all subjects, responses were treated as targets.

After the verification of hearing aids, the participants were followed up monthly by the assessment for determining the effective use and investigation of possible complaints. The group attended the clinic for speech returns, without the need to adjust the settings of the hearing aids. The use of a period of not less than eight hours/day was considered effective, confirmed by the datalogging.

After three months of hearing aid fitting, the survey participants underwent further evaluation of speech perception (HINT) and answered the THI questionnaire.

Statistical analysis

Initially, descriptive analyzes were performed to characterize the population, determine the degree of hearing loss, age of the individuals, the degree of annoyance with tinnitus (THI) and speech perception (HINT).

To establish whether or not there was a statistically significant difference when comparing pre and post-implementation of the THI questionnaire and pre and post of the HINT comparison test, the Wilcoxon test was used.

To see if there was a correlation between the impact of tinnitus (THI) and speech perception (HINT), before and after the use of hearing aids, the Spearman correlation test was used.

THI and pre HINT comparisons were also performed after the use of hearing aids for individuals with hearing loss from mild to moderate, separately, using the Mann-Whitney test.

For all statistical tests, the significance level of 5% ($p<0.05$) was adopted.

RESULTS

The study sample was completed with 27 participants: 15 adult females and 12 males, with a mean age of 66 years.

Regarding the degree of hearing loss, 14 subjects had mild hearing loss and 13 moderate.

The result of the THI pre and post-adaptation of hearing aids showed a significant difference ($p<0.05$), indicating the benefit of hearing aids in relation to decreased sensation of tinnitus. The comparison of pre and post-HINT adaptation of hearing aids did not have a significant difference. Statistical analysis for the THI and HINT by means of the Wilcoxon test, the pre and post adaptation of hearing aids are shown in Table 1.

A significant difference in the perception of tinnitus (THI) and speech perception (HINT) was observed before the hearing aid fitting. However, no difference was observed after the hearing aid fitting. The Spearman correlation, performed to correlate the perception of tinnitus (THI) and speech perception (HINT) before the adaptation of hearing aids, is shown in Tables 2 and 3.

For mild hearing loss, an improvement in the results was observed, since there was decline in the value of the perception of tinnitus, characterized by the THI pre and post-fitting of hearing aids. The speech perception in the proposed situations (pre HINT and post HINT), before and after the hearing aid fitting also indicated improvement. The descriptive analysis comparing the slight loss before and after the hearing aid fitting with the Mann-Whitney test is shown in Table 4.

For moderate hearing loss, better results could also be observed because there was a decrease in the value of the perception of tinnitus, characterized by the THI pre and post--fitting of hearing aids. The speech perception in the proposed situations (pre HINT and post HINT), before and after the hearing aid fitting indicated improvement. The descriptive analysis comparing the moderate loss before and after the hearing aid fitting with the Mann-Whitney test is shown in Table 5.

DISCUSSION

The presence of tinnitus and the difficulty in speech recognition can lead to significant changes in the individual's communication and, consequently, in their quality of life.

In an attempt to resolve the complaint of tinnitus for patients seeking public services, various treatments have been studied. In the present work, we opted for hearing aids[2,9,17] as an intervention.

The use of hearing aids can help in the treatment of tinnitus and also offer benefits for hearing and communication, helping

Table 1. Comparison of pre and post-adaptation of hearing aids

	THI	HINT S	HINT NF	HINT NR	HINT NL	HINT NC
Z	-4.375*	-1.258*	-1.766*	-1.622*	-.661*	-.012*
p	.000	.208	.077	.105	.509	.990

*Significant differences ($p<0.05$) – Wilcoxon test

Subtitle: THI = Tinnitus Handicap Inventory; HINT = Hearing in Noise Test; S = Silence; NF = Noise Front; NR = Noise Right; NL = Noise Left; NC = Noise Composite

Table 2. Correlation between THI pre-adaptation and HINT pre-adaptation of hearing aids

			HINT S	HINT NF	HINT NR	HINT NL	HINT NC
Spearman's rho	THI Pre	r	-.630*	-.660*	-.661*	-.553*	-.695*
		p	.000	.000	.000	.003	.000

*Significant values ($p<0.05$) - Spearman correlation test

Subtitle: THI = Tinnitus Handicap Inventory; HINT = Hearing in Noise Test; S = silence; NF = Noise Front; NR = Noise Right; NL = Noise Left; NC = Noise Composite

Table 3. Comparison between THI post-adaptation and HINT post-adaptation of hearing aids

			HINT S	HINT NF	HINT NR	HINT NL	HINT NC
Spearman's rho	THI Post	r	-.147	-.070	-.122	-.174	-.094
		p	.465	.730	.544	.386	.639

Spearman correlation test ($p<0.05$)

Subtitle: THI = Tinnitus Handicap Inventory; HINT = Hearing in Noise Test; S = Silence; NF = Noise Front; NR = Noise Right; NL = Noise Left; NC = Noise Composite

Table 4. Comparison of mild hearing loss before and after the hearing aid fitting (n=14)

	Mean	Standard deviation	Minimum	Maximum
THI Pre	68.17	18.809	24	96
THI Post	24.17	20.261	0	58
HINT S Pre	12.65	18.908	0	43
HINT S Post	6.58	15.374	0	41
HINT NF Pre	-.500	1.2842	-2.8	1.5
HINT NF Post	.725	1.7940	-1.0	5.5
HINT NR Pre	-2.658	1.7106	-5.0	.0
HINT NR Post	-3.633	2.5213	-7.7	3,0
HINT NL Pre	-3.225	1.7253	-5.9	-.5
HINT NL Post	-3.408	1.9751	-5.8	1,6
HINT NC Pre	-1.717	1.2511	-4.1	.5
HINT NC Post	-1.375	1.7899	-3.1	3.9

Subtitle: THI = Tinnitus Handicap Inventory; HINT = Hearing in Noise Test; S = silence; NF = Noise Front; NR = Noise Right; NL = Noise Left; NC = Noise Composite

Table 5. Comparison of moderate hearing loss before and after the hearing aid fitting (n=13)

	Mean	Standard deviation	Minimum	Maximum
THI Pre	47.00	20.944	8	74
THI Post	18.62	19.500	0	68
HINT S Pre	27.78	32.925	0	83
HINT S Post	25.02	28.884	0	72
HINT NF Pre	3.377	5.3999	-2.0	17.7
HINT NF Post	3.592	3.6816	-1.7	9.9
HINT NR Pre	1.400	4.3843	-3.9	10.9
HINT NR Post	.446	5.3344	-5.1	10.1
HINT NL Pre	1.6085	6.8244	-4.2	21.5
HINT NL Post	.4318	4.4995	-5.1	8.1
HINT NC Pre	2.446	5.3584	-2.5	16.9
HINT NC Post	2.015	4.1527	-3.3	8.7

Subtitle: THI = Tinnitus Handicap Inventory; HINT = Hearing in Noise Test; S = Silence; NF = Noise Front; NR = Noise Right; NL = Noise Left; NC = Noise Composite

some patients with symptoms to differentiate the negative effects of their hearing loss resulting from tinnitus[18].

The participants were 15 adult females and 12 adult males. According to the literature, there is still controversy about the incidence of tinnitus in men and women. Some studies show a higher incidence in men, justified by greater exposure to occupational noise[19,20]. For women, the assumption is that they present a greater willingness to seek medical advice[7,21].

The average age of the group was 66 years. The minimum age was 50 years and maximum of 83 years, according to the literature, which describes that the occurrence of tinnitus is greater from the age of 50, although there is the incidence of age variability[6,7,8,22]. There is therefore an increasing trend in discomfort with increasing age.

When comparing the pre and post THI-adaptation of hearing aids, there was a significant difference, indicating the benefit of hearing aids in relation to decreased sensation of tinnitus (Table 1). These findings agree with studies in the literature[9,17,23] which had positive results with the use of hearing aids.

Tinnitus has been described in conjunction with almost all forms of abnormality of the ear and more often related to cochlear abnormalities[24]. Hearing loss, especially in higher degree, may represent a further handicap for tinnitus, generating additional discomfort and not necessarily influencing the tinnitus nuisance itself, but the sum of problems presented by the patient.

In the present study, subjects with mild hearing loss had a score of 68% in the THI questionnaire and the group with moderate hearing loss had 47%, suggesting that mild hearing loss was more associated with bothersome tinnitus before the adaptation with hearing aids.

Researchers[25] observed that the presence of mild hearing loss in patients with tinnitus with little discomfort and severe and profound hearing loss in tinnitus with great nuisance, were

at odds with what was found in the present study.

Studies used the THI to assess bothersome tinnitus and found that a greater degree of hearing loss is not correlated with most bothersome tinnitus, according to our findings[7].

If we compare the overall results of the pre and post-HINT adaptation of hearing aids (Table 2), we can see improvement in speech perception. However, these results showed no significant differences. There are no studies in the literature correlating the perception of speech in noise situation with tinnitus, so the overall improvement, even if slight, favors the individual's communication and therefore their quality of life.

In the analysis of results (Tables 4 and 5), it was found that the HINT values for mild and moderate hearing loss were more negative, that is, a lower S/N ratio and hence better understanding of the participant's speech provided noise.

In the study of the front HINT correlation before and after the adaptation of hearing aids for mild and moderate losses, we observed a significant difference (Tables 3 and 4). This situation assessment was considered the most difficult for researchers[26,27] that standardized the HINT through the evaluation of 79 adults with normal hearing in four situations: silence, noise ahead, noise and noise from the right to the left.

Although the cure for tinnitus is being actively investigated, currently, there are no proven ways to eliminate this symptom[28].

CONCLUSION

There was an improvement in the degree of tinnitus annoyance after the hearing aid fitting. There was no significant correlation between speech perception before and after the use of hearing aids.

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