

Benefit of Using the Prosthesis with Sound Generators in Individuals with Tinnitus Associated With Mild to Moderately Severe Hearing Loss

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Abstract

Introduction: One of the treatments currently available for the remission of tinnitus, when associated with hearing loss is the use of hearing aids with sound generator. Such treatment is based on the capability that the human brain has to get used to a new sound over another. **Objective:** To describe the results found in a group of people who have undergone treatment with sound generators. **Method:** Audiologic follow-up protocols of 25 adult subjects with hearing loss and complaint of tinnitus were analyzed. It was applied: free field audiometry with hearing aids, Visual Analog Scale to determine the degree of annoyance of the tinnitus and Tinnitus Handicap Inventory to assess tinnitus impact on the quality of life before and after treatment. **Results:** after the use of hearing aids there was significant improvement in hearing thresholds; there was a significant reduction in the degree of annoyance caused by tinnitus; there was a significant reduction of tinnitus and, consequently, on the quality of life of the respondents. **Conclusion:** This study allowed the verification that the use of hearing aids with sound generator is a good resource for the treatment of tinnitus associated with mild to moderately severe hearing loss.

Keywords: hearing loss, hearing aids, tinnitus, speech perception, speech-language pathology.

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INTRODUCTION

Tinnitus can be defined as a sound sensation perceived in the ears or head that is not related to an external source of stimuli¹. The cause can be associated with different etiologies, sometimes overlapping in the same individual, and be influenced by numerous factors². It is described as a symptom that can accompany various pathologies or disorders of the external, middle or inner ear, brainstem and cerebral cortex³, among which are those that affect the ear directly or secondarily (metabolic, cardiovascular, neurological, psychiatric disorders, and possibly drugs, caffeine, alcohol, and nicotine)².

Alterations such as compacted earwax, otosclerosis, exposure to loud sounds, ototoxicity, Meniere's disease, vestibular schwannoma, emotional, dental or spinal factors are commonly related to the perception of tinnitus³, as well as initial peripheral lesions, which follow central neuroplastic alterations^{4,5}. Tinnitus is also defined as the result of the dynamic interaction of several centers of the central nervous system, including auditory and non-auditory pathways. The interaction between these centers, especially between the limbic system and the autonomic nervous system, is responsible for triggering the negative emotional associations and uncomfortable reactions reported by patients with tinnitus^{6,7}.

It is noteworthy that tinnitus sounds can be classified by different criteria⁷⁻¹¹ and can be perceived differently. Some cases related to vascular causes, such as from pulse and heartbeat, are termed as the pulsatile type sounds. Tinnitus sounds such as flapping, crumpling paper, and clicks are often related to the muscles and are usually asynchronous with the heartbeat, often being intermittent. Sound types such as popping and whistling may be related to temporomandibular joint disorder¹¹. Tinnitus is common and, according to studies^{12,13}, affects about 15% of Americans. Tinnitus is considered to be the third worst symptom for humans, surpassed only by intense and intractable pain and dizziness. When manifested in a prominent way, it can significantly impair quality of life, affecting sleep, concentration, emotional balance and social activity, disabling the pursuit of normal activities^{14,15}. To treat people who report the presence of tinnitus, the first step in care is to investigate the patient's history, via anamnesis, which should address, in addition to questions about the actual onset of tinnitus, its peculiarities, associated diseases, the patient's lifestyle, diet, genetics, overall health, and the disorder's current effects on the patient's life¹⁶.

Besides anamnesis, the use of questionnaires is of great importance in the evaluation of individuals with tinnitus because it helps confirm the presence of tinnitus and determine the severity of symptoms¹⁷. The Tinnitus Handicap Inventory (THI) is composed of 27 questions, with a total score ranging from 0 to 100, meaning the higher the score, the greater the impact of tinnitus on the patient's quality of life¹⁸. Another evaluation model is the Visual Analog Scale (VAS). It consists of a graphic-

visual way to determine the level of inconvenience or discomfort caused by tinnitus, on a scale of 0 to 10⁵. In addition to the assessment protocols, audiologic diagnostics, i.e., the identification of some kind of hearing impairment and possible changes in efferent and afferent pathways, is essential¹⁹. In addition to these aspects, the investigation of tinnitus characteristics, i.e., measures of sensation, frequency and intensity¹⁶ are important, as well as laboratory and imaging tests, to rule out retrocochlear lesions, investigation of brainstem auditory evoked potentials, otoacoustic emissions, and an electrocochleography²⁰.

Regarding treatment, it is important to note that there is no specific way to eliminate tinnitus completely, but strategies can be used to minimize the symptoms²¹. Among the non-drug therapies, Tinnitus Retraining Therapy (TRT) is recognized as a treatment with positive results, as described in the literature²². TRT, created by Pawel Jastreboff in 1990, is a technique in which the patient uses devices called sound generators that reduce the perception of tinnitus^{23,24}. The technique consists of two steps. Guidance is the first step, where the patients receive orientation and have their questions about the disorder cleared up. Stimulation with a sound (noise) or "sonorous enrichment" is the second step. Currently, hearing aids with sound generators are commercially available. Based on these assumptions, the aim of this study was to describe the findings in a group of people who underwent hearing treatment with sound generators.

METHOD

This research is characterized as a descriptive study on an experimental basis and it is part of a project entitled "Evaluation of results in hearing health program", approved by the Ethics Committee under number CEP/ UTP 046/2009. The sample was composed of 25 individuals who agreed to participate in the study and signed the consent form. The data collection was carried out between August 2014 and June 2015 in a speech and hearing clinic in the cities of Curitiba-PR, Blumenau-SC, Florianópolis-SC and Goiânia-GO.

The records of subjects of both sexes, adults, with mild to moderately severe hearing loss, in any configuration, and complaints of bilateral tinnitus were analyzed. They were all hearing aid users with sound generators in both ears for at least six months. The sound used in the therapy was calculated for each patient individually, considering the type, pitch and intensity of tinnitus, level of discomfort and other complaints. Individuals with severe and profound hearing loss, unilateral tinnitus and those who failed to respond to the THI were excluded.

For study purposes, the following variables were analyzed: a) the results of pure tone audiometry with and without hearing aids; VAS results to determine the level of annoyance or discomfort caused by tinnitus before and after the fitting; b) THI results to evaluate the

effects of tinnitus on the quality of life before and after using the prosthesis. The data were treated statistically using the Student's t-test and chi-squared test, at a 0.05 significance level.

RESULTS

The sample consisted of 16 women and nine men. The mean age was 52.2 years, with a minimum of 26 and maximum of 61 years of age. All subjects in this study had bilateral hearing loss, sensorineural, and 72% had ski-slope loss. The degree ranged from mild to moderately severe.

The mean by frequency, with and without hearing aids, is shown in (Table 1). To allow the application of statistical tests the frequencies were grouped: 250 500, 1000 + 2000 + 3000 and 4000 + 6000 + 8000. Using the Student's t-test, at a 0.05 significance level (5%), it appears that there is a significant difference between the averages for the three groups of frequencies and was significantly better with prosthesis. Data on type of tinnitus are described in (Table 2). The most prevalent type of tinnitus sound in the studied sample was "wheezing", mentioned by 44% of respondents.

The VAS results are shown in (Table 3) and the results obtained in the THI are shown in (Table 4). Using the chi-squared test at a 0.05 significance level (5%), it appears that there was significant reduction of nuisance caused by tinnitus, as well as an improvement in quality of life after the use of the prosthesis with sound generator. There was no tinnitus remission in any subject investigated in this study, even in the mild annoyance cases. Patients

Table 1. Characterization of the sample according to average hearing thresholds (PTA) in the open field with (WHA) and without (WOHA) hearing aids.

Frequency Hz	WOHA dBNA	WHA dBNA	ρ
5635	23	20	0.0070*
500	32	25	
1000	41	25	
2000	47	26	0.0000*
3000	55	28	
4000	62	25	
6000	60	30	0.0000*
8000	56	35	

Analysis: To allow the application of statistical test, the frequencies were grouped: 250 + 500, 1000 + 2000 + 3000 and 4000 + 6000 + 8000. Using the Student's t-test, at a 0.05 significance level (5%), it appears that there is a significant difference between the averages for the three groups of frequencies and was significantly better with prosthesis.

Table 2. Characterization of the sample according to the type of tinnitus.

Type of tinnitus	Men	Women
Whistling	1	3
Cricket	1	2
Wheezing	3	8
Teapot	1	3
TOTAL	9	16

Table 3. Characterization of the sample according to the VAS protocol before and after using the prosthesis with sound generator considering the type of tinnitus reported.

Type of tinnitus	VAS before prosthesis	VAS after prosthesis	ρ
Whistling	7	4	
Cricket	9	3	
Wheezing	10	3	0.0021*
Teapot	9	3	

Analysis: In the VAS, the greater the result, the greater the nuisance caused by tinnitus. The results were compared before and after, and the chi-squared test at a 0.05 significance level (5%). Results with significant differences ($p < 0.05$) are marked with an asterisk (*).

Table 4. Characterization of the sample according to the THI protocol before and after using the prosthesis with sound generator.

Degree of commitment	THI before prosthesis	THI after prosthesis	ρ
Slight	4	18	
Mild	6	3	
Moderate	12	4	0.0048*
Severe	3	0	
TOTAL	25	25	

Analysis: On the THI, the more severe the compromise, the worse the quality of life. The results were compared before and after, and the chi-squared test at a 0.05 significance level (5%). Results with significant differences ($p < 0.05$) are marked with an asterisk (*).

reported that without the use of the device the tinnitus symptoms reappear, but with less intensity.

DISCUSSION

The cases presented here were referred by an ENT to use conventional hearing aids combined with a sound generator as a form of tinnitus treatment. All patients underwent treatment for a period exceeding 6 months. The average age of respondents was 52.2 years, with a minimum of 26 and maximum of 61 years of age. Findings from other studies suggest that tinnitus can affect people of all ages, but it is in adults and the elderly where symptoms are the most prevalent^{11,5}.

All participants have hearing impairment, even if it was restricted to high frequencies. The literature explains that the association between hearing loss and tinnitus due to injury to hair cells is common¹⁹. The highest incidence of tinnitus symptoms is related to initial peripheral lesions, which follow central neuroplastic changes. About 90% of cases of tinnitus are associated with alterations in conventional audiometry, and that number may be even higher when considering otoacoustic emissions and high-frequency audiometry testing⁷. Of the cases presented, the types of tinnitus sounds described are: wheezing, whistling, cricket, and teapot. These results are consistent with the literature, which describes the wheezing and whistling types as the most common sounds cited by patients, with an average ratio of incidence of 46% of cases, followed by "teapot" and "cricket" sounds^{5,11}, a proven fact in this study.

Before the use of the prosthesis, the respondents characterized the tinnitus as significant and troublesome, as noted in the VAS and THI results. Patients with

tinnitus tend to have varying degrees of discomfort with symptoms, with greater or lesser impact on quality of life. Two factors related to tinnitus are important and should be differentiated: the intensity of the tinnitus symptoms and the discomfort caused to the patient's life²⁵. After the use of the prosthesis the discomfort level decreased significantly in the studied sample, and research^{26,27} shows that the combined use of amplification and sound generators for the relief of bothersome tinnitus seemed to be more efficient than pure amplification, and that this reduction may be observed progressively from the third month of use of the devices²⁸.

It is important to emphasize that when the tinnitus pitch lies within the amplification area of the prosthesis, the greater the reduction in nuisance. In addition, the increase in the auditory stimulus provided by the hearing aid can induce secondary plasticity which may reduce discomfort and would focus the subject's attention away from tinnitus²⁹. In general, the information reported in this study points to a reduction of the negative effects of tinnitus, and that contributes to improving quality of life of the researched population. However, it is important to say that the peculiarities of each case investigated should be analyzed, as well as the vital importance monitoring and professional counseling has during the treatment period, without failing to stressing the need for other treatments aimed at mitigating symptoms and improving the general health of individuals.

It is noteworthy that technological advances in the audiological area have brought great benefits to patients with complaints of tinnitus. The miniaturization of devices, investing in differentiated aesthetics and modern features have been good allies in overcoming the symptoms, for which remission is, in some cases, impossible to achieve. Treating tinnitus is not an easy task and given the complexity involved with its causes and symptoms^{6,27,30}, studies indicate the need for multi- and interdisciplinary approaches, involving various health professionals, with the objective of promoting care and integral attention for people with such impairment⁸. Other studies that follow this kind of patient for longer should be conducted in order to verify the long-term effects of prostheses with sound generators.

CONCLUSION

This study verified that the use of hearing aids with sound generators is a good resource for the treatment of tinnitus associated with mild to moderately severe hearing loss.

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