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Influence of the Cochlear Implantation on Tinnitus Distress among Patients

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ABSTRACT

Cochlear implantation is becoming the standard treatment in patients with severe to profound sensorineural hearing loss. Moreover, tinnitus is a symptom that is highly connected with hearing impairment. The purpose of the study was to assess the influence of CI on tinnitus distress using the Tinnitus and Hearing Survey (THS), Tinnitus Handicap Inventory (THI) and Tinnitus Functional Index (TFI). Twenty adult patients were included in this study with unilateral cochlear implantation. Pre- and postoperative tinnitus perception was evaluated, before, during implant activation visit and 1 month before activation. Of the approached patients, 15 completed the full sets of questionnaire and 5 only Tinnitus and Hearing Survey (THS). Before implantation, the tinnitus prevalence was 75% (15 of 20) in the whole study group. Prior to implantation, the total result THI was 51.6 (SD=22.5) and TFI score was 41.6 (SD=15.3). Postoperatively, the THI scores decreased to 39.3 (SD=27.1) and TFI score reduced to 34.6 (SD=23.5). Moreover, results were analyzed using the Paired Sample t-test. The level of significance was set at $p<0.05$. In conclusion, in present study, cochlear implant improves hearing threshold and can significant reduced tinnitus distress. Although in some cases tinnitus burden changed to worse.

KEYWORDS: Cochlear implant, tinnitus, THS, THI, TFI

INTRODUCTION

Tinnitus (from latin *tinnire* – ring) is defined as a disorder which results from experiencing phantom auditory sensations without any external audio source [1-3].

In most cases, patients define it as "ringing" but sometimes they claim to hear squeaking noises, whistling, whizzing, buzzing, knocking, rumbling, rustling and many other sounds. Mechanisms responsible for tinnitus sensation have not been discovered yet. One of the multiple hypotheses suggests that it is caused by increased or decreased cochlear electrical activity [4]. Another theory assumes that tinnitus results from changes in neural activity caused by reduced (or lost) auditory input, for example due to hearing loss [5].

According to Hoffman [6], it is estimated that this disorder affects about 50 million Americans and 70 million European Union citizens, while according to Punte [7] it affects 10-16% of the world's adult population.

Tinnitus coincides most often with the following phenomena: profound sensorineural hearing loss [2,3,8], ototoxic drug treatment, as well as neurological, metabolic and psychogenic disorders [9]. Only 8-10% of patients with tinnitus have normal hearing [10], while 85 to 96% have some degree of hearing loss [11]. It also may vary when we analyze the age. In school children, it is related with worse marks, more aggressive behavior and sometimes they don't get promotion to higher class. In some regions of the world tinnitus among children from 6 to 12 years old could be present in 6-14% [12-16].

From several research studies that have been conducted so far, we have found out that a large percentage of patients with a cochlear implant experience tinnitus before the surgery. This problem affects 51% to 100% of CI candidates [17-21].

Currently, many tinnitus treatment methods focus on cognitive behavioral therapy [22]. Their aim is to improve habituation based on e.g. the Jasterboff neuropsychological model [23]. Basic treatment involves standard hearing aids, sound enrichment therapy and tinnitus maskers [5]. However, sound therapy is not always effective in patients suffering from profound hearing loss.

The implantation of cochlear implants has become a common practice in treating patients with severe or profound hearing loss, who cannot benefit from hearing aids [24]. Some decades ago all specialists were satisfied when approach to the

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cochlea was proper and engineers could obtain any stimulation [25-27]. Current cochlear users requiremore benefits than improved speech understanding [27,28]. One of the most frequently reported problems, especially in aging population, is concomitant tinnitus. Nowadays, troublesome tinnitus in a hearing-impaired person is listed as the extra criteria worth considering while qualifying patients for cochlear implantation procedure [29-31].

In 1981, House and Brackmann [32] described the impact of cochlear implants on the suppression of tinnitus – the therapy was completely successful in 8-61% of patients. In turn, tinnitus was also reduced in 64-100% of cases. Additionally, research studies conducted by Baugley and Atlas in 2007 [17], and Pan et al. in 2009 [33] have proven that after the implantation, tinnitus was significantly reduced or completely eliminated in 46-95% of patients constituting their research groups. However, there are also several cases of post implantation tinnitus distress increase described in other sources. For instance, Quaranta et al. [18] have observed such a growth in their research, which ranged from 4% to 26% of cases.

This article serves as a summary of the results of an ongoing research study conducted so far on patients experiencing tinnitus, implanted in the World Hearing Center in Kajetany.

MATERIAL AND METHODS

PARTICIPANTS

The study included patients undergoing cochlear implant between July and September 2016 at the Institute of Physiology and Pathology of Hearing (Kajetany, Poland), who completed tinnitus questionnaires. The material constituted of 20 adults (10 female and 10 male) with severe-profound sensorineural hearing loss. All of them were first-time scheduled for cochlear implantation. The mean age at the operation time was 49 ± 18 years (range: 18-70). We excluded all patients under 18 years old.

Table 1 shows biographical data, side of CI, hearing loss etiology and tinnitus localization of all patients who received the CIs. 75% of the study group (n=15) have been suffering from tinnitus; 46.7% of patients (n=7) experienced bilateral tinnitus and 53.3% of patients (n=8) experienced unilateral tinnitus. In this study, contra-lateral tinnitus wasn't considered.

QUESTIONNAIRES

All patients were asked to fill three tinnitus questionnaires in following time intervals: before implantation (1st), before CI activation (2nd) and one month after activation (3rd). We used two questionnaires standardized and adapted into Polish language in our Institute (data yet unpublished): The Tinnitus and Hearing Survey (THS) and the Tinnitus Handicap Inventory (THI). The third questionnaire - Tinnitus Functional Index (TFI), was used in our study under Oregon Health and Science license obtained from authors of the original tool.

Tinnitus and Hearing Survey (THS) published by Henry et al. 2015 [34] is a screening tool. Its main aim is to quickly and efficiently separate hearing problems from tinnitus problems, which in turn allows the clinician to choose the best of available interventions THS consist of 3 parts: the four items in the A (Tinnitus) subscale describe common problems with tinnitus that are unrelated to hearing problems; the four items in the B (Hearing) subscale describe common hearing problems that would not be caused by tinnitus; the two items in the C (Sound Tolerance) are additional, non-standardized and comprise the possibility of hyperacusis experience.

Tinnitus Handicap Inventory (THI) developed by Newman et al. in 1996 [35] assesses tinnitus impact on everyday functioning. The THI consist of 25 items and, according to our adaptation, has

Table 1. Overview of CI population.

Patient ID	Age	Gender	CI side	Etiology	Tinnitus side
1	27	M	right	Sudden deafness	absent
2	50	F	left	Otosclerosis	unilateral
3	63	F	left	ototoxic medicine	absent
4	64	M	left	Trauma	unilateral
5	70	F	right	Sudden deafness	unilateral
6	51	F	left	Sudden deafness	bilateral
7	60	F	right	Sudden deafness	unilateral
8	45	M	right	Sudden deafness	unilateral
9	31	F	right	Otosclerosis	bilateral
10	38	M	left	Sudden deafness (progressive)	bilateral
11	68	M	left	Sudden deafness (progressive)	bilateral
12	18	M	right	Prematurity	absent
13	18	M	left	Prematurity	absent
14	62	M	left	Sudden deafness (progressive)	absent
15	56	F	left	Meniere disease	unilateral
16	51	M	left	Sudden deafness	bilateral
17	66	F	right	Sudden deafness	unilateral
18	68	M	left	Noise in the work	bilateral
19	20	F	Left	Mumps	bilateral
20	61	F	left	Sudden deafness	unilateral

a unidimensional structure. Total score on the THI can range from 0 to 100 points representing maximum possible handicap and its classification is based on five handicap categories proposed by McCombe et al. [36].

The Tinnitus Functional Index (TFI) was published by Meikle et al. in New Zeland [37]. TFI has eight domains that address the intrusiveness of tinnitus, the sense of control the patient has over the disease, cognitive interference, sleep disturbance, auditory issues, relaxation issues, quality of life, and emotional distress. This questionnaire can be used in determining the treatment-related change. TFI has documented validity for both scaling the severity and negative impact of tinnitus on daily functioning. It comprehensively provides coverage of multiple tinnitus severity domains. TFI consist of 25 items. Each item is scored on an 11-point scale, with descriptors at either end of the scale. The procedure for scoring the TFI was followed in our study based on the instructions provided by Meikle et al. [37].

RESULTS

TINNITUS AND HEARING SURVEY (THS)

Table 2 summarizes the change in tinnitus and hearing before and after implantation. 75% of patients (n=15) complained about tinnitus before implantation. Only two patients complained of acquiring tinnitus after operation. However, this sensation completely disappeared after one month. In the time between operation and CI activation alleviation of tinnitus distress was observed in 7 patients and 5 patients reported worsening of their tinnitus.

At follow-up visit 1 month after activation in 10 patients observed reduction of tinnitus, including one person with completely suppressed tinnitus. In this time interval tinnitus remained unchanged in two patients. Furthermore, there was no increase in the problems associated with tinnitus.

Part A (tinnitus) and part B (hearing) mean scores are presented in Table 1. A significant difference ($t=2.44$; $p<0.05$) was found for the hearing score between preoperative and 1 month after activation. However, no significant difference were found the tinnitus score ($t=2.04$; $p>0.05$).

The result of sound tolerance was shown in Table 3. Before implantation hyperacusis was a moderate to very big problem for over half of study group. Additional, after CI two patients start suffering from hyperacusis as moderate problem. However, most of the patients reported a reduction in the problems associated with the auditory sensitivity. A significant reduction ($t=2.45$; $p<0.05$) and thus improvement was found between sound tolerance preoperatively and one month after the first-fitting.

TINNITUS HANDICAP INVENTORY

The analysis included 15 patients experiencing tinnitus. Patients who have never felt the tinnitus (n=5) according to the THS questionnaire crosschecked with the interview were excluded.

The mean THI score of the tinnitus patients was 51.6 (SD=22.5) preoperatively (Table 4) and almost half of the patients were classified as being more than moderatel handicapped (Figure 1).

During implant activation visit tinnitus partially decreased in 20% of patients (n=3). The handicap degree was unchanged 8/15 (53%) patients and worsened in 4/15 (almost 30%) cases.

One month after CI activation tinnitus subsided completely in 13% (n=2) of the study population. Almost 30% (n=4) of patients perceived a reduction in the level of handicap score in comparison with preoperative evaluation. In two cases from severe to slight and in one case from moderate to slight the same situation was observed. Forty-seven percent (n=7) of patients observed no change in tinnitus handicapping influence. Progression of tinnitus occurred in two patients. One of them had a moderate severity score before and this increase to catastrophic tinnitus perception after implantation.

A significant reduction ($t=0.38$; $p<0.05$) and thus improvement was found between THI score preoperatively and one month after the first-fitting.

Table 2. Mean results on Tinnitus and Hearing Survey (THS): part A (tinnitus 0-16), part B (hearing 0-16).

Follow-up	N	Tinnitus	N	Hearing
PRE	15	7.2 ± 4.4	20	13 ± 3.4
Activation	17	8.3 ± 3.4		12.9 ± 2.7
1 month	15	5.1 ± 3.6		10.5 ± 4

Table 3. THS: result of part C (Sound Tolerance).

	Sound Tolerance				
Follow-up (n=20)	**Not a problem**	**Small problem**	**Moderate problem**	**Big problem**	**Very big problem**
PRE	35% (n=7)	10% (n=2)	10% (n=2)	30 % (n=6)	15% (n=3)
Activation	25% (n=5)	20% (n=4)	30% (n=6)	20% (n=4)	5% (n=1)
1 month	25% (n=5)	20% (n=4)	30% (n=6)	10% (n=2)	15% (n=3)

Table 4. Change in tinnitus handicap based on score of THI.

Follow-up	Minimum score	Maximum score	Total score THI (mean ± std. deviaton)
PRE	12	80	51.6 ± 22.5
Activation	12	100	53.7 ± 26.5
1 month	0	86	39.3 ± 27.1

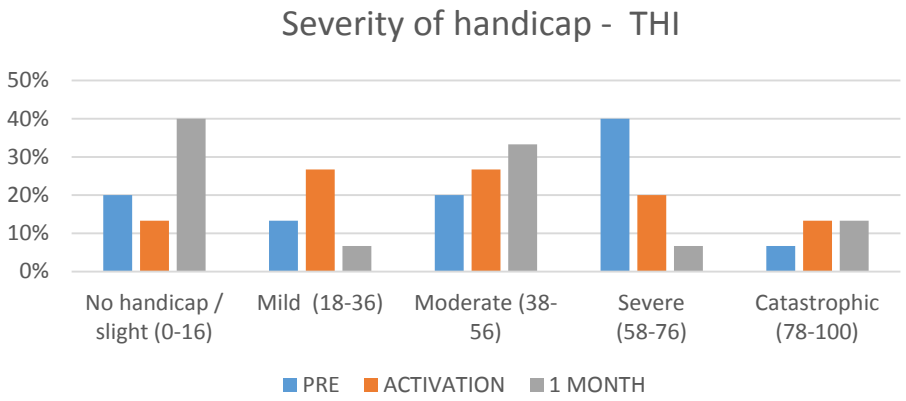

Fig 1. Comparison between pre implantation, activation and post implantation THI.

TINNITUS FUNCTIONAL INDEX (TFI)

Before implantation the biggest problem for patients with tinnitus was its intrusiveness (for around 50% of them). Moreover, tinnitus impaired domains such as: relaxation and quality of life, as well as hearing (Figure 2).

After surgery, the score was like preimplantation score, but additional growth in domains sleep and emotional was observed.

One month after CI activation score in all domains was reduced. A significant difference between preoperatively and 1 month after activation score was found only in domain intrusiveness ($t=3.22$; $p<0.001$).

Using guidelines created by Meikle et al. (2012) for TFI scoring, 40% (n=6) of our patients had a score indicating"not a problem" or "a small problem" whereas 60% (n=9) had score classified as moderate or big problem. Nobody had very big problem before their implantation. However, after surgery 2 patients worsened score from moderate to very big problem. This is compared to 53.3 % (n=8) had a score indicating "not a problem" or "it's a small problem, 33.3% (n=5) had score moderate or big problem, around 13% (n=2) had a very big problem (Figure 3).

As a group, the mean preoperative TFI score was 41.6 (SD=15.5). During activation visit the mean score was 48.6 (SD=24.7) and one month later score reduced to 34.6 (SD=23.5) (Table 5).

DISCUSSION

A lot of Centers in Europe and America

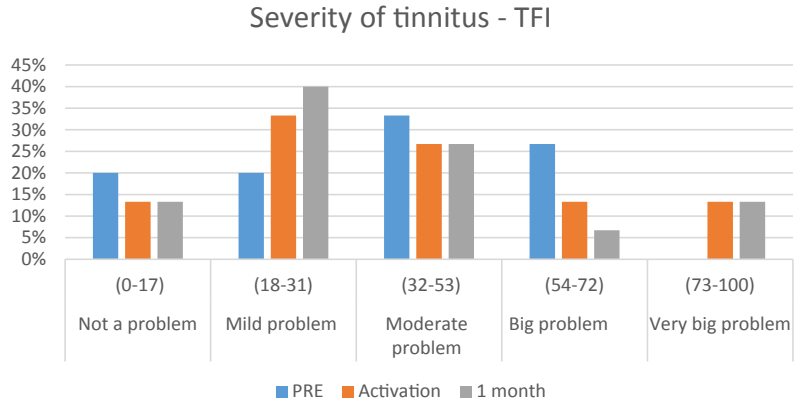

Fig 2. Severity of tinnitus in subscale of TFI.

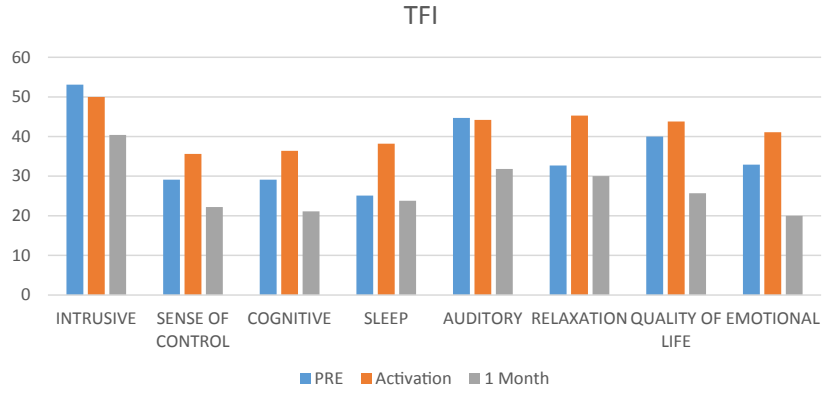

Fig 3. Comparison between preimplantation, activation and postimplantation TFI.

Table 5. Evaluation of average subscale of TFI.

Follow-up	Minimum score	Maximum score	Total score TFI (mean ± std. deviaton)
PRE	4	60.8	41.6 ± 15.5
Activation	14.8	100	48.6 ± 24.7
1 month	0	83	34.6 ± 23.5

have shown that the cochlear implantation not only improve hearing threshold but also successfully reducing the burden of tinnitus during active CI use [38-41]. It is very important from quality of life point of view.

In this study of adult CI candidates, the prevalence of tinnitus was 75% (15/20). Literature was performed base on keywords like tinnitus and cochlear implantation on the most important databases. Literature reported a range of tinnitus suffering in patient candidates of cochlear implantation from 67% to 100% (mean 80%) [17]. The study of Amoodi et al. [42] reported incidence of 78%. Our data seems to confirm this previous series.

Postoperative tinnitus development was perceived in 2 of 5 patients who have never experienced tinnitus before implantation. In our study, new symptoms of tinnitus appeared immediately after operation and total suppression was one month later. This is similar to reports of Kompis et al. [8,19]. This could happen due to position of the body and sometimes is also combined with small vestibular disorders [43-46].

Research of di Nardo et al. [47] shown a decrease of THI score in 13 cases (65%), unchanged score in 6 (30%) and increased score in 1 (5%). In the present study, there is a high rate of patients who reported a tinnitus improvement one month after CI activation: total suppression of tinnitus occurred in 2 patients, the score both THI and TFI was reduced in almost 60% (n=9) patients, increased in more than 26% (n=4).

In present study the baseline total THI score we observed that severity of handicap tinnitus increased on during CI activation visit. In the same follow-up, TFI score increased in domain: relaxation and worsened the trouble with sleep.

The mean THI score of severity of tinnitus was 51.6 ± 22.5 preoperatively and almost 70% of this group had tinnitus severity more than mild. Similar result was reported by Bovo et al. [48] In that study almost 60% of patients were classified as more than mildly handicapped by tinnitus. In study Kim et al. [20] more than 50% sample group suffering from tinnitus in more than mild degree.

There is no study using TFI for patients with impaired hearing. In literature, we can find only research of people with normal hearing threshold. One of them is study Fackrell et al. [49]. The mean score of TFI was 40.6 (SD=20.1), while in our study preimplantation score was 41.6 points (SD=15.5), but 1 month after CI 34.6 (SD=23.5). In addition, intrusiveness of tinnitus caused also problems with sense of control and relaxation. In the present study, we can notice that preoperatively tinnitus have a negative influence on intrusiveness, hearing and quality of life.

SUMMARY

1. The analysis of this study results shows that prevalence of tinnitus in CI patients is relatively high.
2. Pre THI score, the tinnitus severity is generally moderate to severe handicapping, but TFI score shows rather small to moderate problems.
3. A Pearson's correlation was run to determine the relationship between total score THI and THI preoperatively and one month after CI first fitting. There was a moderate positive correlation between THI and TFI preoperatively score ($r=0.57$; $p<0.05$). Total score between THI and TFI one month after CI activation was a strong positive correlation ($r=0.74$; $p<0.05$).
4. After implantation but before activation CI, the severity of tinnitus in both questionnaire increased. Although on next follow-up (1 month) tinnitus was significantly reduced. However, we report also a negative influence of CI on tinnitus in some patients.
5. Our analysis shows a positive result of cochlear implantation on perceived severity of tinnitus.
6. In additional, CI improved quality of life and hearing ability.

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Hearing Profile of Individuals with Tinnitus Issues

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ABSTRACT

Introduction: Tinnitus is the perception of sound not derived from the surroundings, but from within the head or ear of the one who hears it. According to previous knowledge regarding alterations in the functionality of the auditory pathway in the presence of tinnitus, being it related to regular hearing or not, further inquiries and researches are required in other to clarify the subject.

Objective: Summarize the hearing profile of patients with tinnitus complaints.

Methodology: 121 individuals, from both sex, ages ranging from 18 to 82 took part in the experiment, convenience sample, broad demand. Subjects were submitted to tinnitus analysis through anamnesis, acuphenometry and the questionnaire Tinnitus Handicap Inventory, the hearing, on the other hand, was submitted to an audiometry test.

Results: Female individuals were more frequent, where a larger occurrence of bilateral tinnitus, with continuous sound type. Average pitch of 4664 Hz and loudness of 20 dBNS to the right ear and 4685 HZ e 18 dBNS to the left ear, no relevant difference was found when compared. The level of tinnitus disturbance more often found was the mild, followed by the slight. The hearing profile more frequently observed was the hearing loss of isolated frequencies from both ears, followed by regular hearing, both took major roles in influencing the level of tinnitus disturbance classification. The sex has significantly influenced the level of hearing loss, being it more frequent on the feminine sex. The Tinnitus Handicap Inventory is significantly related with the hearing loss of isolated frequencies in both ears.

Conclusion: The characteristic of the hearing profiles studied was the bilateral and continuous tinnitus, of high pitch and loudness between 18 and 2 0dBNS. Level of disturbance between slight and mild, under influence of gender. Hearing loss restricted of isolated frequencies, followed by regular hearing, appeared more often and influenced in the level of tinnitus disturbance.

KEYWORDS: Tinnitus; Hearing loss; Audiology; Hearing; Audiologist

INTRODUCTION

To relax in silence, focus and being able to synchronize with one's thoughts, it's a common and characteristic act of the human being. However, to some people, this type of situation can be disturbing and impossible because of the perception of a sound absent in surroundings, rather inside of the ear or head of the one affected. This sound is called tinnitus, also known as acufeno [1].

It can be defined as a ghost auditory perception realized only by the one afflicted in most cases, making it difficult to measure a pattern [2]. The location can affect only one ear (unilateral), both (bilateral) or the head. English data has estimated that 600 thousand people in the United Kingdom present tinnitus, which has a severe impact in the routine of this population [3]. A research took place in 2004 and suggested that 28 million Brazilians are affected by tinnitus [4]. In addition, a recent study, developed in the city of Sao Paulo, revealed that 22% of that population has said to have tinnitus [5].

The sound perceived by those who suffer from tinnitus may vary, from a low, quiet, background tinnitus, to a very high tinnitus, capable of overlapping external sounds [6]. The tinnitus can be only one sound or more than one, which can be

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permanent or fluctuating. It is believed that this kind of perception is results from abnormal neural activity to a subcortical level of the auditory pathway [7,8]. The tinnitus itself it's not classified as a disease, but rather, a symptom of a variety of underlying diseases. Many otological, metabolical, neurological, cardiovascular, pharmacological, odontological and psychological conditions that can pile up upon themselves in the same individual can cause tinnitus [9].

Among the otological causes, are included the tinnitus induced hearing loss, presbycusis,otosclerosis,otitis,obstructing wax, sudden deafness, Ménière's disease, and other cause of hearing loss [6]. Any bruise to the auditory pathway or any reduction in the auditory nerve's function has the potential to result in the symptom of tinnitus [10]. However, it can also be associated with normal hearing in conventional audiometry, that being said, it's necessary to search for other causes of tinnitus. A study took place in 2010, 36.86% of people affected by tinnitus had normal hearing [11]. This phenomenon is explained by the Otoacoustics Emissions Transients (TEOAE) with smaller amplitude of subjects that alterations in the peripheral level might contribute to the generation of the tinnitus. [12].

A variation at central level can be generated and/or maintainer of the tinnitus. Alterations at the efferent pathway, more specifically at the Superior Olivary Complex (SOC), might be one of the causes of the tinnitus in patients with normal hearing [13]. The human cochlea receives innervation of COS efferent fibers. Those systems affect directly the cochlear modulation, as both inhibitory and exciting [14].

If the individual, in fact, presents hearing loss, being it whatever otology behind it, it is one base disease related to the symptom of tinnitus. About 85 to 96% of patients with tinnitus show some level of hearing loss [15,16]. In study about hearing loss in adults through 48 and 92 years old, it was discovered the prevalence of tinnitus in 8.2% of the subjects of the first study, five years later that number would drop to 5.7% [17]. The presence of tinnitus is directly connected with aging [18].

Most patients suffering from hearing loss and tinnitus say the tinnitus frequency is related to severeness and the characteristic frequency of the hearing loss, the tinnitus's intensity is usually lower than 10 dB above the patients hearing threshold of this isolated frequency [7].

In cases of hearing loss, being the patient enable to receive prosthetics adaptation, as a means to enhance the external sound, could be one way to treat tinnitus [19], indirectly. Knowing they are projected to improve the audibility of speeches and to amplify the environment sounds. This factor deflects the attention from the tinnitus, partially masking it [20].

From previous knowledge about the variations of auditory pathway's functionality in the presence of tinnitus, being it related to regular hearing or not, it's necessary further enlightenment and more researches on the subject and in favor of the population searching for support in the diagnosis and treatment of tinnitus, improving the way of life of the affected population. The main goal of this paper is to trace a profile of patients with tinnitus complaints.

METHODOLOGY

This descriptive and transversal study was performed at school clinic of the Speech Therapy course from a university of Joao Pessoa. 121 volunteers, aged between 18 and 82, 78 females and 43 males, took part in this experiment. The sample was by convenience, non-probabilistic sampling and of spontaneous demand. The volunteers needed to be above 18 and refer tinnitus, both uni and bilateral.

According to the 466/12 resolution, of the National Health Council, in reference to ethics involving researching with human beings, the study was approved by the Ethic Committee in Researching with Humans. (Protocol n.: 0129/12).

The volunteers accepted taking part in the study by signing the Terms of Free and Enlightened Consent; they were submitted to a series of evaluations. The evaluations procedures were anamnesis, specific questionnaire about tinnitus, audiological tests of audiometry, acuphenometry, and the Tinnitus Handicap Inventory questionnaire.

The anamnesis was performed in order to obtain data such as age, gender, tinnitus location (right ear, left ear, both ears or head), time of emergence (days, months or years), how it came to be (gradual, sudden or after noise exposure), type of tinnitus (continuous, modulated frequency or noise) characteristics of the sound (whistle, rain wheezing, waterfall, bee, others).

The THI questionnaire was used as a potential measure to classify the disturbance caused by tinnitus, in form of an interview to leave no doubt. It is composed of 25 questions, allowing the participant to choose between the answers "yes, "no" and "sometimes", the score of "4 points", "0 points" and "2 points" was given respectively to each one of them. The questions spread across functional aspects, emotional and catastrophic of the tinnitus, creating an index that classify the disturbance as "slight", "mild", "moderate", "severe" and "catastrophic, the total sum can vary from 0 to 100 [21]. Depending on the result, the level of disturbance, is classified as slight (0-16), mild (18-36), moderate (38-56), severe (58-76) or catastrophic (78-100) [22].

In regards to the tests performed at an acoustic room and using the Vibrasom AVS 500 audiometer. Tests such as Tonal Audiometry (aerial pathway and bone pathway), to determine the auditory's threshold of the patients, Acuphenometry, to obtain loudness data (sensation of intensity), pitch (sensation of frequency) and the sound type (Continuous Pure Tone, Modulated Frequency, Narrow Band noise or Wihte Noise) referred by the patient as the closest sound possible to his tinnitus.

In Tonal Audiometry, the following frequencies were evaluated: 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hertz (aerial pathway) and 500, 1000, 2000, 3000 and 4000 Hertz (bone pathway) using Modulated Frequency stimulus, from higher intensity (120 dB) to the lowest, until the patient's auditory threshold is reached. Regarding hearing loss cases, the classification is given according to its shape of manifestation, being it unilateral or bilateral, origin/

location as conductive, sensorineural or mixed [23] and severeness, performing one arithmetic mean between the frequencies 500, 1000, 2000 and 4000 Hertz in the auditory pathway. Classifying them as slight the auditory limits between 26 to 40 dBNA, moderated between 41 to 60 dBNA, severe between 61 to 80 dBNA and profound, those who obtained auditory thresholds from 81 dBNA onwards [24]. In case of hearing loss, restricted to certain frequencies, where bone conduction was not performed, them being acute or low, or yet both, [7], the terms "hearing loss of isolated frequencies" or "undetermined level of hearing loss" will be used.

However, to measure loudness, pitch and the type of sound coming from the tinnitus, an acuphenometry was performed, psychoacoustic measure, even though this is a categorization supplied by the patient only, within its particularities, as endless possibilities of sound that can be called tinnitus and the test's limitation due to a shortage of sounds [25]. This way, the patient can identify which tinnitus is similar to his own.

When the tinnitus was unilateral, the sound was supplied to the contralateral ear, if bilateral, in the ear with best hearing [22]. This way, firstly the type of sound was researched (Pure Continuous Sound, Modulated Frequency, Narrow Band and White Noise), in order to find pitch, by staying in this first instant, there is a loudness of 10 dB above the auditory threshold of the patient. The patient has chosen between two different sounds, for instance, one sound of 125 Hz and another of 8000 Hz, while wondering "which one of these sounds is more alike my tinnitus?" expressed in Hertz (Hz), corresponding to the perception of frequency of the tinnitus. In order to, at last, find the loudness, it being the increase, 1 dB at a time, of sound intensity. The result was expressed in dBNS (level of satisfaction). This order was used in order to prevent the patient from not hearing the stimulus due to the hearing loss being in the same frequency as the tinnitus.

A descriptive analysis of statistics was performed, in order to verify the frequency, average and standard deviation of the variables studied. Followed by an inferential analysis of statistics, with the adequate tests to verify the comparison between the values of each ear, using the parametric t test of Student for independent samples to variables with intervals of normal distribution, or with it corresponding non-parametric of Wilcoxon; For the correlation between variables The Spearman Correlation test was performed as means to identify the degree of relationship between pairs of variables of interest, as: THI x age, THI x gender, THI x Level of Hearing Loss, THI x Type of Hearing Loss.

The differences were considered relevant when $p<0.05$ was presented. The statistical analysis was performed through the Statistical Package for Social Sciences (SPPS), version 2.0.

RESULTS

The research had 121 participants with average age of 48, 71 years. Them being 78(64.5%) female and 43 (35.5%) male.

In regards to the location of the tinnitus, a larger occurrence was observed when in the bilateral state (Table 1). As of the relation degree with THI, a larger frequency of mild level was observed (Table 2).

Performing the analysis of the type of sound, ears were considered separately. This way, for both ears, there was higher frequency of the tinnitus with continuous type of sound 51.2% to the right ear and 52.9% to the left.

As it follows, an analysis of the auditory profile of those individuals was performed, split by ears. Having observed that the type of hearing loss of isolated frequencies, those restricted to specific frequencies and in which degree of hearing loss it is not classified, was the most frequent. Followed by regular hearing in both ears (Tables 3 and 4).

Table 1. Descriptive analysis of the location of tinnitus.

Variables	Nº	%
RE	23	19.0
LE	28	23.1
Bilateral	59	48.8
In the Head	11	9.1
Total	121	100.0

RE=right ear; LE=left ear

Table 2. Descriptive analysis of the THI degree.

Variables	Nº	%
Slight	26	21.5
Mild	34	28.1
Moderate	25	20.7
Severe	18	14.9
Catastrophic	18	14.9
Total	121	100.0

Table 3. Descriptive analysis of the auditory profile by ear.

Ears	Variables	Nº	%
Right	Normal	40	33.1
	HL isolated freq.	44	36.4
	HL sensorineural	24	19.8
	HL conductive	1	0.8
	HL mixed	12	9.9
	Total	121	100.0
Left	Normal	36	29.8
	HL isolated freq.	43	35.5
	HL sensorineural	22	18.2
	HL conductive	1	0.8
	HL mixed	19	15.7
	Total	121	100.0

HL=hearing loss

When put together, the data from THI with the information of hearing profile by ear, became clear that the right ear has the biggest relation with the degree of hearing loss of isolated frequencies, followed by regular hearing with the slight level of THI. The left ear, on the other hand, showed that the slight level of THI was bigger in both regular hearing and hearing loss of isolated frequencies (Tables 5 and 6).

Performing the comparison between the variables of level hearing loss of left and right ears, using the Wilcoxon Signed Ranks, there was no meaningfulness (r=0.467). The right ear had an average of 1.5455 (DP 0.96609). meanwhile. The left ear 1.6281 (DP 1.05777). Therefore, the relation of level of disturbance of tinnitus with the degree of hearing loss was not relevant, seeing that there was a larger frequency of hearing loss of isolated frequencies, in which the degree is not classified.

The average values of pitch and loudness found were 4664Hz and 20.61dBNS for the right ear, and 4685Hz and 18.83dBNS for the left ear, using the t test of Student.

Correlating the average of pitch (r=0.907/ p=0.000) and loudness (r=0.650/ p=0.000) between the right and left ears, through the correlation test of Spearman, a meaningfulness of (p<0.05) was observed. However, when correlated to the variable age, there was no relevance.

The Spearman test was performed (p<0.05) in order to correlate the variables sex, age, level of THI, auditory profiles and levels of hearing loss. Thus, a correlation between the female sex and the level of unclassified hearing loss for the right ear (r=0.192/ p=0.035), was perceived. Although, when correlating gender with hearing loss, no meaningfulness was found, the same happened when correlating any variable with age.

Comparing THI with the type of hearing loss, through the Spearman (p<0.05) test, a relevance was also noticed in both ears (OD r=0.194/ p=0.033; OE r=0.241/ p=0.008). The highest scores of hearing loss of isolated frequencies.

Table 4. Descriptive analysis of the level of hearing loss by ear.

Ears	Variables	Nº	%
Right	Unclassified	84	69.4
	Slight	17	14.0
	Moderate	14	11.6
	Severe	3	2.5
	Profound	3	2.5
	Total	121	100.0
Left	Unclassified	79	65.3
	Slight	21	17.4
	Moderate	14	11.6
	Severe	1	0.8
	Profound	6	5.0
	Total	121	100.0

Table 5. Crossing of data from THI and auditory profile of the right ear.

Variables*			Auditory profile				
			Normal hearing	HL isolated freq.	HL sensorineural	HL conductive	HL mixed
THI	slight degree	Nº	13	8	3	0	2
		%	10.7	6.6	2.5	0.0	1.7
	mild degree	Nº	10	15	7	0	2
		%	8.3	12.4	5.8	0.0	1.7
	moderate degree	Nº	10	8	6	0	1
		%	8.3	6.6	5.0	0.0	0.8
	Severe degree	Nº	4	6	5	1	2
		%	3.3	5.0	4.1	0.8	1.7
	Catastrophic degree	Nº	3	7	3	0	5
		%	2.5	5.8	2.5	0.0	4.1

Cross tabulation test

HL=hearing loss

Table 6. Crossing of data from THI and auditory profile of the left ear.

Variables*			Auditory profile				
			Normal hearing	HL isolated freq.	HL sensorineural	HL conductive	HL mixed
THI	slight degree	Nº	9	11	3	0	3
		%	7.4	9.1	2.5	0.0	2.5
	mild degree	Nº	11	14	5	0	4
		%	9.1	11.6	4.1	0.0	3.3
	moderate degree	Nº	10	6	5	0	4
		%	8.3	5.0	4.1	0.0	3.3
	Severe degree	Nº	2	7	3	1	5
		%	1.7	5.8	2.5	0.8	4.1
	Catastrophic degree	Nº	4	5	6	0	3
		%	3.3	4.1	5.0	0.0	2.5

Cross tabulation test

HL=hearing loss

DISCUSSION

The tinnitus usually affect the male population [11,26], increasing its occurrence with aging [26,27]. This research has found individuals with average age of 48 years old, females were more frequent, and this might be explained by a larger demand of from this population in agreement with another study [27].

Regarding the location of the tinnitus, a greater number of individuals with bilateral tinnitus could be observed through this study, in agreement with other study [26]. As for the THI level, the mild degree was noticed more often, concurring with another study [11].

The type of sound more usually found, in this study, for both left and right ears, was the pure continuous tone, result also reported [11].

Concerning the hearing loss, for both ears, there was a higher occurrence of hearing loss of isolated frequencies, in other words, those which are in specific frequencies, low, acute, or both. Other study has found a greater number of hearing loss for acute frequencies related to the tinnitus [28]. One can infer that this phenomena happens due to hearing loss being related to the frequency spectrum of the tinnitus [29].

As for the level of hearing loss, there was no relation between the severeness of the hearing loss and bigger disturbance of the tinnitus. The occurrence of the tinnitus can depend on the severeness of the hearing loss, however no other material was found in order to backup this hypothesis, this happens because individuals who don't present tinnitus have worse hearing than the ones who do [29]. As well as, 78% of the individuals with tinnitus had a slight or moderate level of hearing loss [30].

In order to describe the pitch of tinnitus, an average corresponding to the acute frequency of both ears, was found, in agreement with other study [11,28]. However, the tinnitus's loudness, there is a conflict of ideas, seeing that in, another study higher averages of the tinnitus's intensity were found [11].

Associating sides with pitch and loudness measures, a meaningfulness correlation was perceived in this study, so, the intensity and frequency of the tinnitus of one ear is equivalent to its opposite. This relation was already described, even though it had a weak relevance [29]. Nevertheless, there was a study where this didn't happen [31].

The results of the crossing between THI and auditory profile in the present study, showed a greater relation of hearing loss restricted to isolated frequencies with the slight and mild level of THI and regular hearing with a higher mild level of THI. Another study has found meaningfulness in the mild level, as far as both regular hearing and hearing loss are concerned. [11].

In the present study, there was a higher relevance when relating gender and level of hearing loss. Concluding that the gender influenced the level of hearing loss directly, this can be explained by the fact that males are more exposed to occupational noise [27], on the other hand, there is the fact that females are more likely to seek medical attention. When correlating the gender with the type of hearing loss, there was no relevance, as well as, no variable when correlated with age has presented meaningfulness, agreeing with other study [31].

When correlating, in this study, THI, the level of disturbance created by the tinnitus, with the level and type of hearing loss, relevance was observed in both ears. It has already been written that the odds of having tinnitus with disturbance ranging from moderate to severe, increase with the enlargement of auditory's threshold of higher frequencies, even though the level of hearing loss doesn't affect the disturbance caused by the tinnitus [32]. A higher rate of hearing loss can represent one more handicap when associated with tinnitus, generating an additional disturbance to the patient and not necessarily influencing the disturbance of the tinnitus itself, and yet, they pile up on issues resented by the patient [33].

CONCLUSION

Based on the results obtained in this study, it is possible to conclude:

- Females were more frequent;
- The location of bilateral tinnitus is the most common;
- The continuous type of sound was the most reported;
- The average pitch was 4664 Hz (OD) and 4685 Hz (OE), and loudness was 20 dBNS (OD) and 18 dBNS (OE);
- The rate of disturbance more often found were slight and mild;
- The hearing loss of isolated frequencies, followed by regular hearing, had more influence on the THI levels;
- The type of hearing loss influence THI, having a larger occurrence of isolated frequencies.

This way, it's important to create an auditory profile of people who are afflicted by tinnitus, in order to find them treatment. For example, the use of auditory devices capable of emitting noise masking sounds, so the disturbance can be decreased, when both associated with regular hearing or with hearing loss of isolated frequencies.

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