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ORIGINAL ARTICLE

Correlation of tinnitus and sensorineural hearing loss- A descriptive study

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ABSTRACT:

Introduction: The purpose of this study was to more precisely identify how hearing loss affects tinnitus. To achieve this, we compared the frequency and intensity of tinnitus matches with hearing loss on an audiogram. **Materials and Methods:** Each participant underwent a detailed history and clinicalexamination followed by a pure tone audiogram. In history patients were asked their age at first appearance of the tinnitus and its duration. Also, they were asked for a description of the sound; most patients were able to describe their tinnitus as whistling or buzzing. If the description did not fall into either of these categories, it was defined as "other." For spatial localization, patients were asked to describe their symptoms as being either left- or right sided or as non lateralized. In regard to variability over time, certain patients described their tinnitus either as stable over time or as fluctuating (usually louder at bedtime and on awakening). **Results:** Tinnitus was often attributed to ear pathology (31%) or in fewer cases to any systemic illness (12%). In 17% of cases, the tinnitus appeared in association with psychological problems such as emotional trauma, depression or episodes of stress or anxiety. Finally 5% of patients described "other" as the context. **Conclusion:** This study shows that sensorineural hearing loss is associated with a high-pitched whistling tinnitus that is stable over time, occurs in either ear. The descriptive aspects of tinnitus are strongly correlated with hearing loss as demonstrated by pure-tone audiometry.

Keywords: sensorineural hearing loss, tinnitus, ear, pure-tone audiometry

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INTRODUCTION

Tinnitus, which can be defined as "a sound felt for more than five minutes at a time, in the absence of any external acoustical or electrical stimulation of the ear and not happening immediately after exposure to loud noise," is derived from the Latin word "tinnire," which means "to ring." Epidemiological information on tinnitus is still inconsistent today. Even said, research from the past does highlight the high prevalence of tinnitus. One in ten adults in the United Kingdom report having tinnitus. [1] Tinnitus is a condition that typically coexists with hearing loss and is shown to occur in about 15% of Indians. [2] It is believed to be an auditory perception resulting from spontaneous activity, coming from an altered state of excitation or inhibition within the auditory system, despite the fact that different disorders have been explained. [3] The oldest mention of tinnitus treatment dates all the way back to ancient Egypt, and it persisted into the mediaeval ages. However, no specific treatment has been found to far. Approximately 7% of adults believe their tinnitus is severe enough to require medical attention. [4] When asked, 5% of respondents reported having irritable tinnitus, 1% said their tinnitus was a disability, and 0.5% said they couldn't lead a regular life. [5] Another study that looked at the quality of life of 603 people with tinnitus clearly demonstrated that 26% of patients experienced difficulty with daily life due to their condition. [6] Tinnitus causes noticeable behavioural changes and a definite decline in quality of life. Both tinnitus patients and their family typically speak of irritability, tension, worry, and a decline in sleep quality. Tinnitus seems to have an impact on a patient's personal and professional life. Internal family ties are negatively impacted, particularly because it may be difficult for family members to comprehend what a tinnitus sufferer is going through. Tinnitus is almost often linked to a hearing loss with a documented aetiology (e.g., presbycusis). Many cases of tinnitus are known to have their roots in noise trauma. [7] One can expect the emergence of a whole new generation of tinnitus sufferers, taking into consideration the sound levels in factories and noise of vehicles, such as in train or bus drivers or in people living near railway tracks, bus stands, or near highways, or from personal stereos (especially people working in call centres listen to telephone all day or chronic music listeners when listen through headphones). The purpose of this study was to more precisely identify how hearing loss affects tinnitus. To achieve this, we compared the frequency and intensity of tinnitus matches with hearing loss on an audiogram.

MATERIAL AND METHODS

The descriptive study was conducted on 50 patients randomly selected of tinnitus reported in department ENT. The informed consent was taken from all the patients and ethical clearance was taken from ethical committee of the institution. Each participant underwent a detailed history and clinical examination

followed by a pure tone audiogram. In history patients were asked their age at first appearance of the tinnitus and its duration. Also, they were asked for a description of the sound; most patients were able to describe their tinnitus as whistling or buzzing. If the description did not fall into either of these categories, it was defined as "other." For spatial localization, patients were asked to describe their symptoms as being either left- or right sided or as non lateralized. In regard to variability over time, certain patients described their tinnitus either as stable over time or as fluctuating (usually louder at bedtime and on awakening). Descriptions outside of these categories were defined as "other."Intensity was measured on a visual analog scale graded from 0 to 100, where 0 corresponded to an absence of tinnitus and 100 indicated the loudest tinnitus imaginable. Tinnitus handicap inventory (THI) score was administered on all participants, followed by an objective evaluation of tinnitus pitch and loudness matching using the ascending descending combined procedure. Initially, the participant was allowed to select the noise, music, or environmental sound of their choice. The participant was then asked to adjust the volume of sound to a comfortable level with intervals oftinnitus in the stimulus. The collected data were entered in Microsoft excel and statistical analysis was done using SPSS version 11.5. Paired *t*-test was done and $P < 0.05$ was taken as statistically significant. We considered the length of history, age at presentation, intensity of the tinnitus, and any associated hearing loss as continuous variables. We analyzed the description of the sound of the tinnitus, its spatial localization, and the variability of the intensity as non continuous variables. Depending on the variables under analysis, a Student's *t*-test or chi squared testing was undertaken. We used chi-squared testing to study any associations between two variables in a class, ANOVA testing to study variables in the same class and continuous variables, and Pearson correlation coefficients to compare two continuous variables. All the data, whether in a table or in text, are expressed as the mean plus or minus the standard deviation. For more clarity, data plotted in the graphs are expressed as the mean plus or minus the standard error of the mean.

RESULTS

Table 1 shows that out of total 60 patients, males were 59% and females were 43%. Age range of patients was from 20 to 70 years. Average age of presentation was 45 yrs. Tinnitus had first been noticed by the patients at an average age of 40 years. Therefore, patients had been suffering from tinnitus for an average of 5yrs prior to presentation. In 40% of cases, the tinnitus appeared spontaneously (i.e., without any clearly identifiable cause).

Table 1: Total No. of Patients Gender Wise

Total patients	Male	Female
60	**34 (59)`**	**26 (43)**

Tinnitus was often attributed to ear pathology (31%) or in fewer cases to any systemic illness (12%). In 17% of cases, the tinnitus appeared in association with psychological problems such as emotional trauma, depression or episodes of stress or anxiety. Finally 5% of patients described "other" as the context (Table 2).

Table 2: No. of patients affected due to different causes

Causative factors	No of patients
Spontaneous	**22 (41%)**
Ear pathology	**17 (30%)**
Psychological causes	**10 (17%)**
Systemic illness	**7 (12%)**
Other	**4 (5%)**

With regard to a clinical diagnosis, 90% of tinnitus patients had a sensory (cochlear) hearing loss, 3% a retro cochlear hearing loss, and 2% a conductive hearing loss (Table 3). Analysis of the audiograms of the tinnitus patients showed a predominantly left-sided hearing loss, particularly in the higher frequencies.

Table 3: No. of patients with different type of Hearing Loss

Type of Hearing Loss	No. of Patients
Sensorineural hearing loss	**47 (91%)**
Retrocochlear hearing loss	**3 (3%)**
Conductive hearing loss	**3 (3%)**
Normal audiogram	**5 (7%)**

We asked the patients to classify their tinnitus with regard to spatial localization and frequency, intensity, variability with time, and duration. We found that most patients described their tinnitus as whistling (79%), buzzing (21%) and other (4%) (Table4). Patients described tinnitus as stable in (87%), fluctuating in (11%) and 4% as other. Tinnitus is more noticeable either within the left ear or on the left side (47% left ear, 41% right ear) and non lateralized in 16%., the left ear being the ear in which hearing loss on audiometry was more obvious. However, this spatial localization wasnot statistically significant.

Table 4: No. of Patients with different type of Tinnitus

Type of tinnitus	No of patients
Whistling	43 (79%)
Buzzing	14 (22%)
Other	3 (4%)

Hearing Loss: The overall population patientsshowed a mainly left-sided high-frequency hearing loss (4,000 Hz) but the degree of hearing loss was significantly lower than that in patients suffering from other ear pathology. In concordance with our audiometric

finding, the intensity of tinnitus perception was significantly correlated with the degree of hearing loss measured between 2,000 and 8,000 Hz. The greater the hearing loss, the stronger the correlation became. Correlation coefficients were 0.38, 0.55, 0.56, and 0.59 at 2,000, 4,000, 6,000,and 8,000 Hz, respectively. In 80% of cases, patients described their whistling tinnitus as stable over time. We observed no significant difference in the average age of patients depending on whether they described their tinnitus as stable (45years) or fluctuating (50 years), but those with stable tinnitus had it for a longer period (8years) as compared to those who described fluctuating tinnitus (2 years).

Frequency Characteristics: In this study, almost all the patients who had a history of noise exposurree said that their tinnitus was of a high pitched whistling frequency. Statistical analysis showed a significant correlation between noise trauma and whistling tinnitus. The whistling sound was significantly linked to a high- frequency hearing loss.

Intensity Evaluation: To measure loudness oftinnitus patient is asked to adjust an external sound to match loudness of tinnitus. Often matching sound is then presented to 2nd ear to avoid matching sound masking the tinnitus or reducing its loudness. Tinnitus was matched by sound with low sensation level at 5 or 10 dB SL. We noted, however, that the few patients who described their tinnitus as fluctuating over time had generally had their tinnitus for a shorter period (2+-2 years versus 7.9+-11.9 years for stable tinnitus). This being the case, we propose two hypotheses: (1) Fluctuating tinnitus tends to stabilize after a certain length of time or (2) fluctuating tinnitus may disappear, whereas long standing tinnitus is stable. Only a longitudinal study of tinnitus patients will allow us to clarify these hypotheses further.

DISCUSSION

Males made up the majority of tinnitus sufferers in our study (58%) while females made up the majority of tinnitus sufferers in Davis et al's study. [8] The average age in our sample was 45 years old at the time of presentation, however Hiller and Goebel found that older males experienced greater intensity and severity. [9] Pinto et al. found no association between the discomfort tinnitus produces and age, sex, or duration of the condition. [10] In contrast to studies where only about 8-10% of tinnitus patients have normal hearing, in our study 96% had some sort of hearing loss and 4% had a normal audiogram. [11] Between 85 and 96 percent of them experience hearing loss. [12] According to a descriptive perspective, the tinnitus that the patients in this study described was primarily whistling, remained steady throughout time, and was felt on the left side. This latter conclusion is consistent with prior research that demonstrate that hearing loss and tinnitus are typically more obvious on the left side, even if it is not statistically significant. [13] In addition, individuals had experienced their tinnitus for an average of 7 years before to visiting a tinnitus clinic, regardless of the pathology that caused it to manifest. This might be because the study was conducted in a medical facility, which frequently serves as a secondary or tertiary referral centre for tinnitus patients. In our investigation, nearly every patient with a history of noise exposure claimed to have high-pitched whistling as the frequency of their tinnitus. According to statistical investigation, whistling tinnitus and noise trauma are significantly correlated. The whistling noise was strongly associated with a hearing loss at high frequencies. This connection is consistent with a previous study on a smaller sample that discovered a correlation between a whistling form of tinnitus and a high-frequency hearing loss. [7] Hearing loss at high frequencies was linked to the severity of tinnitus. The amount of hearing loss and the intensity of tinnitus were found to be significantly correlated. According to Mazurek et al., persons with persistent tinnitus who are decompensated have higher hearing loss than those who are compensated. Thus, the study's findings provided evidence for the theory that the degree of hearing loss and the intensity of tinnitus are related. [14] Similar outcomes have been seen in other research. The frequency of tinnitus as determined by pitch matching was shown to correlate with high frequency hearing loss (equivalent to noise stress) by Cahani et al[15]. Eggermont and Roberts'[16] research showed a strong correlation between tinnitus frequency and audiometric hearing loss. In other words, auditory threshold and the frequency spectrum of tinnitus are inversely related. If this were the case, high frequencies would be expected to dominate the spectrum of whistling tinnitus that is observed following noise damage. This theory could be verified by additional research.

In this study, we used a visual analogue scale to measure the level of tinnitus. Using this tool, we found a strong correlation between the tinnitus intensity and hearing loss between 2,000 and 8,000 Hz. The stronger the association, the higher the frequency of hearing loss. These findings are consistent with a recent study of 58 patients, which shown that when the high frequency loss becomes more pronounced, the severity of stable whistling tinnitus is reported as becoming stronger. It is challenging to compare our findings using a visual analogue scale to those from studies in which participants were asked to score the frequency and intensity of their tinnitus using an external sound, often a pure tone produced by an audiometer. Interpretation is complicated in these circumstances since patients could only hear the external sound if it was provided 5–15 dB beyond their threshold for hearing. Should tinnitus, for instance, be regarded as having a low intensity (only 10 dB) or being stronger than the hearing loss would imply if it has been

measured at 10 dB above the auditory threshold? Would one have to conclude that the severity of tinnitus relies on hearing threshold and that there is a proportionate relationship between tinnitus and hearing threshold if tinnitus is measured in this way at 5–15 dB above the threshold? Clear answers to those concerns can only be provided by a study contrasting the two methods of tinnitus intensity rating (audiometric-based pitch matching and visual analogue scale). A visual analogue scale, however, appears to be the best tool for understanding the incapacitating nature of tinnitus linked to noise stress given the correlation between hearing loss and the degree of tinnitus that we observed in this study. Typically, sounds with low sensation levels at 5 or 10 dB SL correspond to tinnitus. In 41% of patients with tinnitus, 69% of patients with 10dB SL or less, and 87% of cases with 20dB SL, Reed discovered matches to a level of 5dB or less. [17] Vernon stated that there were no matches above 20dB SL. [18] Similar outcomes are also produced by recently introduced computerised techniques for measuring tinnitus loudness.

In the current study, the relationship between pure tone thresholds and tinnitus loudness matching intensity was explored. It was discovered that there was a positive correlation between tinnitus loudness matches obtained at the frequency of maximum hearing threshold, indicating that as hearing threshold increases, tinnitus loudness is perceived to be louder. The obtained tinnitus pitch matches showed no discernible trend. However, tinnitus matches at or below 2000 Hz were discovered in 71.8% of the subjects.

CONCLUSION

This study shows that sensorineural hearing loss is associated with ahigh-pitched whistling tinnitus that is stable over time, occurs in either ear. The descriptive aspects of tinnitus are strongly correlated with hearing loss as demonstrated by pure-tone audiometry. Clearly, as many forms of tinnitus exist as there are patients. However, this attempt at categorizing patients' tinnitus as a function of both the etiology and the semiology allows us to evaluate better the medical and psychological treatment of these tinnitus patients. In addition, such a step allows us to better define those populations that are similar to the experimental models of tinnitus and on which therapeutic strategies are being developed.

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