Original Article

STUDY OF CORRELATION OF TINNITUS AND SENSORINEURAL HEARING LOSS

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Abstract:
Aim-The present study is to find out an association of tinnitus with sensorineural hearing loss. Tinnitus is often associated with hearing loss of a unknown etiology. Material and Methods- 50 cases of tinnitus were taken who on examination have normal tympanic membrane and normal external and middle ear. Audiogram was done in these cases and tinnitus was matched. This subset of patients was mainly male and on average have sensorineural hearing loss. Results- The hearing loss is significantly have sharp dip at a particular frequency than that measured in the other patients of SN hearing loss. Statistical analysis showed a significant correlation between a SN hearing and the presence of a high-pitched "whistling" tinnitus. The presence of whistling tinnitus was significantly correlated with high-frequency hearing loss. Conclusion-The intensity of tinnitus, measured using a visual analog scale, appeared to be stronger than the measured hearing loss would suggest.
Key Words: Sensorineural Hearing Loss, Inner Ear, Ringing Ears

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INTRODUCTION:
"Tinnitus" stems from the Latin term "tinnire" which means "to ring" and may be defined as "a sound perceived for more than five minutes at a time, in the absence of any external acoustical or electrical stimulation of the ear and not occurring immediately after exposure to loud noise." Even today, epidemiological data on tinnitus remain patchy. Despite this, studies to date do underline the high prevalence of tinnitus. In the United Kingdom, 10% of the adult population admit to experiencing tinnitus.[1] The incidence of tinnitus is found to be around 15% in india and is usually associated with hearing loss.[2] Although various pathologies have been explained, it is thought to be an auditory perception due to spontaneous activity, arising from an altered state of excitation or inhibition within the auditory system.[3] The first account of treatment of tinnitus goes all the way back to the Egyptians and continued throughout the middle ages . However to this day, no precise treatment has been identified. Approximately 7% of the adult population judge their tinnitus to be sufficiently severe to warrant consulting a doctor.[4] When questioned, 5% of adults stated that they had irritating tinnitus, 1% of adults considered themselves handicapped by their tinnitus, and 0.5% were unable to live a normal life.[5] A further study focusing on the quality of life of 603 tinnitus sufferers showed clearly that in 26% of patients, tinnitus created difficulties in everyday life.[6] The presence of tinnitus engenders notable modifications of behaviour and a clear deterioration in quality of life. Irritability, stress, anxiety, and deterioration in quality of sleep are frequently described both by tinnitus patients themselves and by their families. Tinnitus appears to affect both the professional and the family life of its sufferers. It has a deleterious effect on intra family relationships, especially because of the difficulty that relatives may have in understanding what the tinnitus sufferer is undergoing. In the vast majority of cases, tinnitus is associated with a hearing loss of known etiology (e.g., presbycusis). Noise trauma is known to be associated with the origin of many cases of tinnitus.[7] Taking account of the sound level in factories and noise of vehicles like 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 entire day or chronic music listeners when listen through headphones), one can anticipate the advent of an entire new generation of tinnitus sufferers. The aim of this study was to define more clearly the effect of hearing loss on tinnitus. To do this, we compared tinnitus match frequency and intensity with hearing loss on audiogram.

MATERIAL AND METHODS: The descriptive study was conducted on 50 patients randomly selected of tinnitus reported in department ENT of GGS Medical College Faridkot. 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 of tinnitus 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 50 patients, males were 58% and females were 42%. 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). Tinnitus was often attributed to ear pathology (30%) or in fewer cases to any systemic illness (10%). In 16% of cases, the tinnitus appeared in association with psychological problems such as emotional trauma, depression or episodes of stress or anxiety. Finally 4% of patients described "other" as the context (Table 2). With regard to a clinical diagnosis, 90% of tinnitus patients had a sensory (cochlear) hearing loss, 2% a retro cochlear hearing loss, and 2% a conductive hearing loss (Table 3). Only 6% of patients had a normal pure-tone audiogram (hearing loss of _10 dB between 250 and 8,000 Hz). Analysis of the audiograms of the tinnitus patients showed a predominantly left-sided hearing loss, particularly in the higher frequencies. 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 (78%), buzzing (20%) and other (2%) (Table4). Patients described tinnitus as stable in (86%), fluctuating in (10%) and 4% as other. Tinnitus is more noticeable either within the left ear or on the left side (46% left ear, 40% right ear) and non lateralized in 14%., the left ear being the ear in which hearing loss on audiometry was more obvious. However, this spatial localization was not statistically significant.

Table 1: Total No. of Patients Gender Wise

Total patients	Male	Female
50	29 (58%)	21(42%)

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

Causative factors	No of patients
Spontaneous	20 (40%)
Ear pathology	15 (30%)
Psychological causes	8 (16%)
Systemic illness	5 (10%)
Other	2 (4%)

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

Type of Hearing Loss	No. of Patients
Sensorineural hearing loss	45 (90%)
Retrocochlear hearing loss	1 (2%)
Conductive hearing loss	1 (2%)
Normal audiogram	3 (6%)

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

Type of tinnitus	No of patients
Whistling	39 (78%)
Buzzing	10 (20%)
Other	1 (2%)

Hearing Loss: The overall population patients showed 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 of tinnitus 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: In our study tinnitus was more prevalent in males (58%) while in study of Davis et al there were more problems with tinnitus in females as compared to males.[8] In our study average age was 45 yrs at the time of presentation but Hiller and Goebel showed more intensity and severity in old men.[9] Pinto et al showed no correlation between age, sex or duration of tinnitus and discomfort it causes.[10] In our study 96% had some type of hearing loss and 4% had normal audiogram as compared to study in which only about 8-10% of patients of tinnitus have normal hearing.[11] 85-96% of them have some degree of hearing loss.[12] From a descriptive point of view, the tinnitus described by the patients in this study was mainly whistling, was stable with time, and was perceived on the left side. Although not statistically significant, this latter finding is in accordance with other studies showing that hearing loss and tinnitus are generally more noticeable on the left side.[13] Finally, whatever the pathology responsible for the appearance of tinnitus, patients had suffered for an average of 7 years before being seen in the tinnitus clinic. This may be related to the fact that this study was undertaken in a hospital setting, which tends to be a secondary or tertiary referral clinic for patients with tinnitus. In our study, almost all the patients who had a history of noise exposure 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. This link correlates with an earlier study on a smaller population showing that a whistling type of tinnitus was correlated with a high-frequency hearing loss.[7] Severity of tinnitus was related to hearing loss at high frequencies. A significant correlation was found between degree of hearing loss and tinnitus loudness. Mazurek et al found that patients with decompensated chronic tinnitus have more hearing loss than with compensated ones. Thus the study had evidence to support hypothesis of correlation between severity of tinnitus and degree of hearing loss.[14] Other studies have shown similar results Cahani et al[15] showed a correlation between high frequency hearing loss (corresponding to noise trauma) and the frequency of tinnitus as measured by pitch matching. Eggermont and Roberts[16] demonstrated that the frequency of tinnitus is closely correlated to audiometric hearing loss. In other words, the frequency spectrum of tinnitus is inversely proportional to auditory threshold. If this were the case, one would expect that the whistling tinnitus noticeable after noise trauma would have a spectrum predominating in high frequencies. A further study would allow verification of this hypothesis.

In this study, we evaluated the intensity of tinnitus by using a visual analog scale. With this instrument, we significantly correlated the intensity of the tinnitus with the degree of hearing loss between 2,000 and 8,000 Hz. This correlation became stronger with the higher frequencies of hearing loss. These results agree with the previous study of 58 patients which showed that the intensity of stable whistling tinnitus is perceived as increasingly strong as the high frequency loss is more marked.[7] It is not easy to compare our results using a visual analog scale with those studies wherein patients are asked to evaluate the frequency and intensity of their tinnitus with an external sound, usually a pure tone generated by an audiometer . In these cases, patients were able to perceive the external sound only if it were presented 5–15 dB above their auditory threshold, which poses a problem with interpretation. For example, should tinnitus that has been measured at 10 dB above the auditory threshold be considered as low intensity (only 10 dB) or stronger than the hearing loss would suggest? With tinnitus measurable in this way at 5–15 dB above the threshold, would one have to say that the intensity of tinnitus depends on hearing threshold and that a proportional relationship exists between tinnitus and hearing threshold? Only a study comparing the two types of tinnitus intensity evaluation (audiometric-based pitch matching and visual analog scale) will allow clear answers to those questions. However, the correlation between hearing loss and intensity of tinnitus that we measured in this study suggests that a visual analog scale is the tool of choice to help us to understand the incapacitating character of tinnitus associated with noise trauma Usually tinnitus is matched by sound with low sensation level at 5 or 10 dB SL. Reed found matches to a level of 5dB or less in 41% of tinnitus patients, to 10dB SL or less in 69% of patients and to 20dB SL in 87% cases.[17] Vernon reported no matches higher than 20dB SL.[18] Recently introduced computerized methods for assessment of tinnitus loudness also produce similar results.

The current study attempted to explore relationship between the pure tone thresholds and tinnitus loudness matching intensity and found a positive correlation between tinnitus loudness matches obtained at the frequency of maximum hearing threshold indicating that as threshold of hearing increases, the perception of tinnitus loudness increases. Tinnitus pitch matches obtained did not follow any specific pattern of matches. However, it was found that 71.8% of the participants had tinnitus matches at or below 2000 Hz.

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. 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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