

Comparison of Protocols Consideration for Pure Tone Averages in Clinical Diagnosis of Presbycusis

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Abstract

Background: Adults suffer with age related hearing loss or Presbycusis which is even progressive due to auditory deprivation condition. Therefore, hearing aids are one of the most important recommendations for SNHL cases. The compromised speech perception ability may be due to the improper diagnostic procedures for Pure tone average calculations to diagnose the hearing loss and even due to the software programming methods requiring the Pure tone average to hearing aid fittings may also be inappropriate.

Aims and objective: The purpose of this research article is to provide insight on the two Pure tone audiometry protocols to diagnose hearing loss in only presbycusis cases. **Materials and Method:** The severity diagnosis of hearing loss is based on 3 frequencies (500Hz, 1KHz, 2KHz) vs 4 frequencies (500Hz, 1KHz, 2KHz, 4KHz) Pure tone average calculations. Pure tone audiometry was performed on 30 subject participants in this study within age group of 50-75 yrs. Statistical analyses was done through SPSS software.

Results and discussion: The findings revealed no significant differences in PTA calculation over the 2 different protocols and therefore no changes in diagnosing the severity of SNHL due to Presbycusis were observed in this study.

Keywords: Pure tone average, PTA- Pure tone audiometry, Noise induced hearing loss, Presbycusis

Introduction

Presbycusis refers to bilateral age-related hearing loss. Old age hearing loss or Elderly hearing loss becomes noticeable at the age of 60 years. Presbycusis is divided into 6 categories which are: Sensory, Neural, Strial, Mechanical, Mixed, and Intermediate Presbycusis. Pathophysiological factors affecting Presbycusis-related hearing loss are the factors which are genetic, ototoxic, noise exposure factors & hormonal factors^[1]. Age effects are noted on the peripheral and central auditory system causing changes in cognition, perception speech understanding in noise and reverberating environment. The latter concerns even with aural rehabilitation programs remains for auditory aspects which prevent the individuals to perform active role and maintain proper quality

living in the society^[2]. There are different types of Presbycusis changes noted: 1) Sensory presbycusis is slowly progressive in nature involving the basal end of the Organ of Corti. Early changes of Cochlear hair cells are flattening and the epithelial mound remains undifferentiated on the basilar membrane; 2) Neuronal Presbycusis majorly reflects clinically loss of speech discrimination and no recruitment. Primarily the basal turn is in condition of microscopic abnormality more; 3) Strial Presbycusis is slowly progressive from the age of 30 years to 60 years and therefore, mostly a flat gradual descending audiogram with recruitment may be possible in such cases. This condition has the patch atrophy on apical turns of stria vascularis; 4) Cochlear conductive presbycusis occurs within middle age onset and

is progressive with no real pathologic changes. Presbycusis changes in older people can be of two types of pathologic changes 1. Organ of Corti changes 2. Spiral ganglion neuron changes. These changes are characterized by a high frequency hearing loss & poor speech discrimination & pure tone losses^[3, 4]. Audiology clinics traditionally use one of the first diagnostic tests to evaluate hearing adults with pure tone audiometry^[5] and that is considered to be the gold standard hearing assessment diagnostic test. This physiological aging can be treated symptomatically with the provision of hearing aids if the threshold shift is 30 dB or more in the speech frequency range. Speech frequency range is the entire speech banana and it shows loss of speech comprehension with Presbycusis. Pure tone audiometry is the diagnostic procedure which is gold standard to give adequate amplification characteristics through programming to the pure tone loss. Pure tone audiometry test is used to correctly diagnose the presbycusis condition therefore, only if by following 2 different protocols of 3 frequencies Pure tone average or the 4 frequencies Pure tone average knowing which one of the two protocols may be of more benefit if compared further on clinical diagnosis of severity of hearing loss or now is better during programming of amplification devices and of benefit to Elderly hearing loss condition^[6]. A common method of summarizing pure tone average for pure tone audiometry findings is the arithmetic mean of threshold at 500 Hz, 1000 Hz & 2000 Hz^[7]. The relationship between PTA and speech audiometry has also been of interest to audiologists so far^[8, 9]. Most organizations across communities don't specify PTA frequencies for diagnosing the severity of hearing loss like Korea, and Japan. Pure tone audiometry protocol for diagnosis of degree of hearing loss has been suggested preferable for 4 frequencies. This is used as Pure tone average protocol, especially when good ear is poorer thresholds than 25 dBHL as mentioned Herefordshire clinical commissioning group U.K and even in National Institute for Health and Clinical Excellence, NICE protocol^[17].

Need for the Study:

Presbycusis, age-related hearing loss, is a prevalent condition among the aging population. Accurate assessment and diagnosis are crucial for providing appropriate intervention and rehabilitation. The choice of audiometric protocols can impact the interpretation of presbycusis, affecting treatment decisions. Many clinics and audiologists use three-frequency and four-frequency pure tone averages, for writing the interpretation of hearing loss in older adults. This variability in practice raises questions about the consistency and reliability of these interpretations. By comparing the effects of three-frequency and four-frequency pure tone averages, this research addresses a significant gap in our understanding of hearing loss assessment in the aging population.

Aims & Objectives:

The study aimed to compare the interpretation of the Three-Frequency Pure Tone Average (3FPTA) and the Four-Frequency Pure Tone Average (4FPTA) among individuals with presbycusis. The objective is to investigate the clinical utility and practicality of using either the 3FPTA or 4FPTA in audiological assessments for individuals with presbycusis. The study was done to identify and compare potential differences in the interpretation of presbycusis when using the 3FPTA versus the 4FPTA, including any variations in severity classification and treatment recommendations. By addressing these objectives, the study aims to contribute valuable insights to the field of audiology and improve the precision and interpretation of individuals with presbycusis.

Method:

In this study, participants were selected based on an ENT doctor's prescription, referred for pure tone audiometry. All subjects were diagnosed as Presbycusis patients by the ENT doctor. 30 participants in this study were 18 males and 12 females in the age range of 50-75 years. The pure tone audiometric examination was performed using Maico MA 42 Puretone Audiometer, Model: MA42, according to ASHA methods for Pure Tone Audiometry [ANSI S3.21-2004; ANSI 2004a]. The test frequencies

of the hearing thresholds were 250 Hz, 500 Hz, 1KHz, 2 KHz, 4 KHz, and 8KHz. Three frequency PTA was calculated from the average thresholds in 500 Hz, 1 KHz, and 2 KHz. Four frequency PTA was calculated from the average thresholds in 500 Hz, 1 KHz, 2 KHz, and 4KHz. Data were recorded in an Excel sheet. SPSS (v21) was used for the statistical analysis.

Result and Discussion:

An independent-sample t-test was conducted to compare the pure tone average threshold using three frequencies and four frequencies. For the Right ear, there was no significant difference obtained in the pure tone average using three frequencies (M=58.05, SD=14.74) and four frequencies (M=62.69, SD=14.02); $t(58) = -1.249$, $p = 0.217$. For the Left ear, there was no significant difference obtained in the pure tone average using three frequencies (M=60.51, SD=13.32) and four frequencies (M=64, SD=11.99); $t(58) = -1.066$, $p = 0.291$ (as shown in figure 1). For clients with 65 years and less, there was no significant difference obtained in the pure tone average of both ears using three frequencies (M=55.39, SD=11.37) and four frequencies (M=59.50, SD=10.00); $t(74) = -1.675$, $p = 0.098$. For clients with more than 65 years, there was no significant difference obtained in the pure tone average of both ears using three frequencies (M=66.00, SD=15.72) and four frequencies (M=69.98, SD=14.91); $t(42) = -0.861$, $p = 0.394$ (as shown in figure 2).

The findings of this study reveal that there were no statistically significant differences in the pure tone averages for both the right and left ears when comparing the use of three frequencies versus four frequencies for PTA calculation. The criteria followed for audiological diagnosis of hearing loss both pure-tone audiometry and the functional measures of speech communication are however followed on WHO guidelines, 1991 but direct correlation is linked to appropriate hearing aid fittings and programming^[10]. In this study, when stratifying the data by age, no significant differences were observed within Group 1 (65 years and less) and Group 2 (more than 65 years). According to Lowell et al. in 1977, patients in the age group less than 65 years consistently showed

audiograms as flat or basin-shaped curves and gradual decline^[11]. From a logical perspective, in cases of flat or basin-shaped audiograms, the 3FPTA and 4FPTA results will closely resemble each other. The result of the present study also suggests that the choice of using three or four frequencies in pure tone audiometry does not significantly impact the assessment outcomes in terms of pure tone averages across two selected age groups. Further research and clinical validation may provide additional insights into the utility of 3FPTA and 4FPTA in audiological assessments. A research study finding on dead regions by Anna P. et al, 2014 associated steeply sloping hearing impairments at 4 KHz, in men and older participants of greater importance^[12].

Conclusion:

The findings of this study shed light on the impact of three and four-frequency PTA on audiological interpretation across two distinct age groups. Our research revealed that whether three or four frequencies were employed in the audiometric testing, there was no significant difference in the interpretation. This suggests that the choice of using three or four frequencies of PTA has a minimal effect on the accuracy and reliability of interpretation in the specified age groups. Presbycusis is more often the damage to the outer hair cells (OHC's) and inner hair cells (IHC's) and damage to Auditory nerve fibres. Even while examining the auditory system as hardly functioning at all when there are dead regions, that the 3 Frequency PTA procedure has been found more effective. The relevance of 4 Frequency average for PTA diagnostic procedure is applicable more in NIHL cases in TTS (Temporary Threshold Shift) and PTS (Permanent threshold shift) audiological case diagnosis. In patients of flat hearing loss and with dead regions or sloping high frequency hearing loss, the 3 Frequency PTA procedure hearing loss, the 3 Frequency PTA procedure is just found to be good sensitive and effective^[13]. Alternatives to PTA of traditional procedure also exist. Some researchers stated nontraditional PTA method of importance too^[14]. High-frequency pure-tone average (HFPTA) in studies have been done

with subjects that presented a sloping hearing loss evaluated for frequency-compression hearing aids^[15] and studies of the contribution of high-frequency information on speech recognition for hearing aids fitting purpose (Amos & Humes, 2007) have been noted^[16]. The HFPTA is considered appropriate because the configuration of the hearing loss primarily above 2000 Hz and the speech information of interest frequencies are found to be greater than 2000 Hz, and, indeed, HFPTA is correlated to better speech recognition in some sloping high frequency hearing loss cases may be found in different types of presbycusis^[14].

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