HIGH-FREQUENCY AUDIOMETRY IN THE DIAGNOSIS OF PATIENTS WITH TINNITUS

Suvorkina A.,
Odessa National Medical University
Otolaryngologist of the department of Otorhinolaryngology
Valyhovsky lane, 2, Odessa, Ukraine
Suvorkina O.
Audiologist of Odessa Medical Hearing center
Shevchenko Prospect, 27, Odessa, Ukraine

Abstract

This study describes the problem of tinnitus, the perception of sound in the absence of any objective physical sound source. Hearing loss is an important risk factor of tinnitus. Therefore, it is very important to use all available resources in the early stages of diagnosis.

But a large number of patients with tinnitus have normal hearing thresholds on pure tone audiometry in the standard frequency range (125 Hz – 8000 Hz). In our study, we used high-frequency audiometry in an extended range from 9,000 Hz to 20,000 Hz. Our research shows that high-frequency audiometry provides additional information in patients with tinnitus who have a normal standard audiogram. Therefore, we recommend the use of high-frequency audiometry in the early stages in the algorithm for diagnosing high-frequency tinnitus for further correct management of patients with tinnitus, which will improve their quality of life.

Keywords: tinnitus, high-frequency audiometry, extended frequency range, hearing loss, quality of life

Introduction. Tinnitus is a widespread problem of the 21st century according to rising rhythm of life and increasing acoustic load. Based on literature data, about 10-15% of the adult population complains of tinnitus [1]. Tinnitus is a noise in the ears, often described by patients as ringing, whistling or buzzing. It is a complex symptom defined as the perception of sound that does not have an objective, appropriate external source. It is subjective since the sound can only be heard by the patient and there are no objective measures to determine its presence or measure it. Tinnitus is often accompanied by depression and anxiety disorders, which negatively affects the quality of life and functional state of health of patients [2]. To estimate the impact of tinnitus on a person's quality of life, various questionnaires are used (Tinnitus Handicap Questionnaire, Tinnitus Handicap Inventory (THI) , Tinnitus Functional Index, Tinnitus Primary Function Questionnaire) [3].

The most common cause of noise is hearing loss, since the frequency spectrum of noise most often corresponds to the frequency range of hearing loss [4,5,6]. However, in such cases, disturbance is usually detected using traditional tone audiometry in the frequency range from 125 Hz - 8 kHz, which is the most important spectrum for speech understanding and is determined by air and bone conduction using bone vibrator headphones respectively, which cannot exclude damage of hair cells in the extended high-frequency spectrum [7]. There are studies describing HF audiometry, but normative data are still absent [8]. Existing researches show that threshold measurement in an extended high frequency range is used for early detection of hearing loss, monitoring of auditory function in people working in noise and predisposition to developing occupational sensorineural hearing loss; in patients treated with ototoxic drugs [9].

The aim of this study was to find out whether the results of HF audiometry would provide any additional clinically relevant information in patients with normal hearing thresholds in the standard range up to 8000 Hz. In examining ща patients with tinnitus complaints in the high frequency range ("crickets in the ears", cicadas, the sound of a broken TV), we used high-frequency audiometry.

Materials and methods. From September 2020 to January 2022 we examined 75 patients (35 women and 40 men) with complaints of high-frequency tinnitus. The average age was 37.25. Selection criteria: age up to 50 years, complaints of high-frequency tinnitus (whistling, ringing) with normal tone audiometry thresholds up to 8000 Hz, > 38 points on the THI questionnaire scale, normal tympanometry parameters (Tympanogram type A, registration acoustic reflex).

We divided the patients into 3 groups:

In the first group, we examined 25 patients - 33.3% of the total. The average age in the group was 35.8. All 25 people complained of high frequency tinnitus. We excluded the professional factor of increased acoustic load at work. At the same time, in the first group, we identified 2 subgroups: a) patients with unilateral noise and b) patients with bilateral noise. The second group consisted of 27 people with complaints of tinnitus in both ears (36%) with an average work experience in conditions of increased acoustic load of 5 years. The average age in the group was 37.2. In the third group, we included 18 volunteers without complaints with normal average hearing thresholds in the frequency range from 125 Hz to 8000 Hz, whose average age was 32.5. All patients filled the Tinnitus Handicap Inventory questionnaire, the results of which were estimated using the Tinnitus Handicap Inventory Severity Scale.

We also included tympanometry and acoustic reflex testing in the algorithm of examination to exclude the conductive component. All patients underwent pure tone audiometry in the traditional range from 125 Hz to 8000 Hz, as well as high-frequency audiometry in the range from 9000 to 20000 Hz. Pure tone audiometry

was performed using an AD629 audiometer. The average hearing thresholds for air and bone conduction were determined by the standard method in the frequency range from 125 Hz to 8000 Hz. Extended high-frequency audiometry was carried out in a complex manner using the AD629 audiometer and DD450 high-frequency headphones. The reduction in hearing thresholds was approved when reaching a level of 20 dB at one or more frequencies.

Results. We found that all 75 patients with tinnitus had normal hearing thresholds on the audiogram in the standard range of 125 Hz to 8000 Hz (<15 dB). High frequency audiometry in patients of the first group with complaints of unilateral tinnitus revealed reduction in hearing thresholds in the range from 9000 to 20000 Hz on the affected side, and the tone of disturbing noise coincided with the corresponding frequency. The average hearing threshold was 27.26 ± 12.25. The highest hearing thresholds were noted at frequencies of 14000-16000 Hz (Fig. 1).

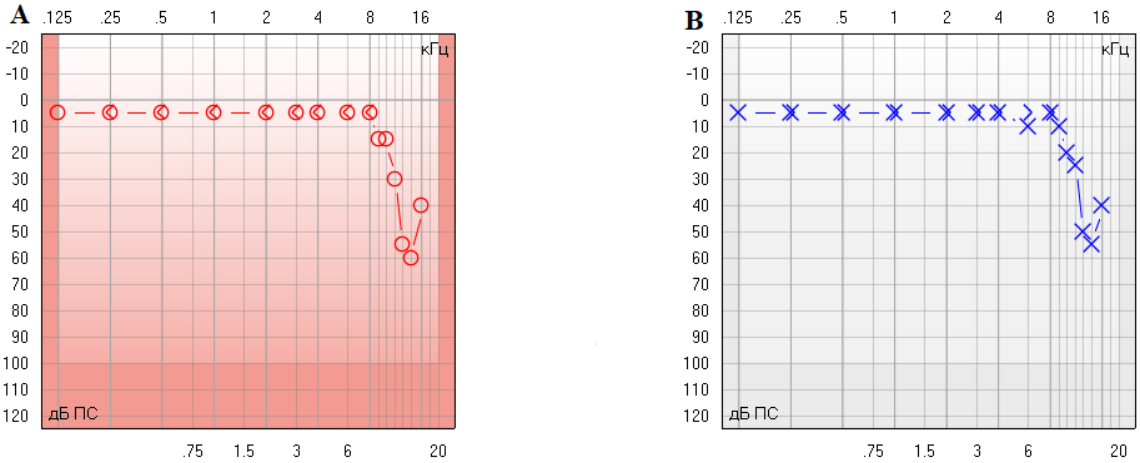

Fig.l.A. High frequency audiogram of right sided tinnitus with normal thresholds on the left ear. B. High frequency audiogram of left sided tinnitus with normal thresholds on the right side.

In the group with bilateral noise decrease of the average thresholds was observed on both sides and riched to 35.79 ± 6.74, and the patients also noted that the sound of the applied signal at the most affected frequency "merges" with its own noise and causes the greatest subjective difficulty in the examination process. The highest hearing thresholds were also noted at frequencies of 14000-16000 Hz.

In the second group of patients who had experience of working in noisy conditions, there was also decrease of the average threshold of audibility of high frequencies on both sides amounted to 42.25 ± 10.12. We received the highest hearing thresholds at frequencies of 12000 Hz, 14000 and 16 Hz (Fig. 2 A). In 12 people of the second group, hearing thresholds at frequencies of 18 kHz and 20 kHz were not recorded (16% of the total number of examined).

In the third control group, patients showed normal average hearing thresholds in the extended high frequency range - 2.28 ± 1.84 (Fig. 2 B).

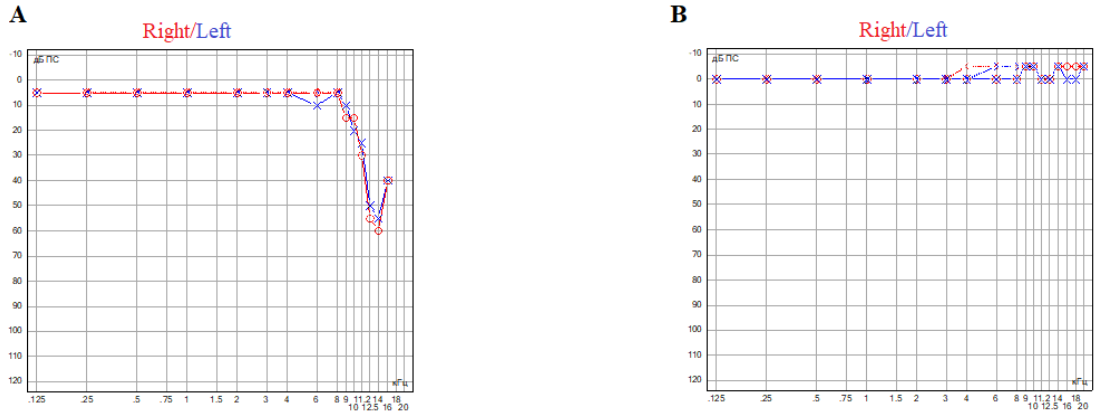

Fig. 2.A. High frequency audiogram with the highest hearing thresholds at frequencies of 12000 Hz. 14000 and 16 Hz. B. High frequency audiogram with normal average hearing thresholds in the extended high frequency range.

Thus, our studies confirm that HF audiometry is more sensitive for diagnosing hearing loss than standard audiometry. We also found a relationship between the character of noise in one ear and the laterality of tinnitus. Patients with left-sided tinnitus also have more expressed HF audiometry changes on the left ear, while patients with right-sided tinnitus have reduced thresholds in HF range on the right ear. Correspondence between the laterality of the noise and the asymmetry of the impairment confirms opinion that hearing loss is involved in the formation of tinnitus and proves the relevance of high-frequency audiometry in the diagnosis of tinnitus.

Conclusions. Thus, we not only demonstrate well known relationship between the presence of tinnitus and hearing loss. In our study, we also note the relationship between laterality and height of tinnitus, which is important in the early stages of diagnosis to prevent the progression of the process and adequate correction tactics, which will be the goal of our next study. In tinnitus patients with normal thresholds, high-frequency tonal audiometry provides additional information. Also, the relationship between the directionality and tone of tinnitus suggests a possible causal role for high-frequency hearing loss in the etiopathogenesis of tinnitus. Therefore, we recommend the use of high-frequency audiometry in the early stages of tinnitus diagnosis. This allows early correction which will improve the quality of life of such patients.

References

1. Dawes P, Newall J, Stockdale D, Baguley DM. Natural history of tinnitus in adults: a cross-sectional and longitudinal analysis. BMJ Open. 2020 Dec 10;10(12):e041290. doi: 10.1136/bmjopen-2020-041290. PMID: 33303456; PMCID: PMC7733183.

2. Thompson DM, Hall DA, Walker DM, Hoare DJ. Psychological Therapy for People with Tinnitus: A Scoping Review of Treatment Components. Ear Hear. 2017 Mar/Apr;38(2):149-158. doi: 10.1097/AUD.0000000000000363. PMID: 27541331; PMCID: PMC5325252.Emily J. Watts «Why Is Tinnitus a Problem? A Qualitative Analysis of Problems Reported by Tinnitus Patients». Trends Hear. 2018 Jan-Dec; doi: 10.1177/2331216518812250

3. Watts EJ, Fackrell K, Smith S, Sheldrake J, Haider H, Hoare DJ. Why Is Tinnitus a Problem? A Qualitative Analysis of Problems Reported by Tinnitus Patients. Trends Hear. 2018 Jan-Dec; 22:2331216518812250. doi: 10.1177/2331216518812250.

4. Noreña A, Micheyl C, Chéry-Croze S, Collet L. Psychoacoustic characterization of the tinnitus spectrum: implications for the underlying mechanisms of tinnitus. Audiol Neurootol. 2002;7(6):358–369

5. Schecklmann M, Vielsmeier V, Steffens T, Landgrebe M, Langguth B, Kleinjung T. Relationship between Audiometric slope and tinnitus pitch in tinnitus patients: insights into the mechanisms of tinnitus generation. PLoS One. 2012;7(4):e34878. doi: 10.1371/journal.pone.0034878. Epub 2012 Apr 18. PMID: 22529949; PMCID: PMC3329543.

6. Vielsmeier V, Lehner A, Strutz J, Steffens T, Kreuzer PM, Schecklmann M, Landgrebe M, Langguth B, Kleinjung T. The Relevance of the High Frequency Audiometry in Tinnitus Patients with Normal Hearing in Conventional Pure-Tone Audiometry. Biomed Res Int. 2015;2015:302515. doi: 10.1155/2015/302515. Epub 2015 Oct 25.

7. Chiemi Tanaka PhD Diagnosis and Rehabilitation of Hearing Disorders in the Elderly Geriatric Rehabilitation, 2018.

8. Škerková M, Kovalová M, Mrázková E. High-Frequency Audiometry for Early Detection of Hearing Loss: A Narrative Review. Int J Environ Res Public Health. 2021 Apr 28;18(9):4702. doi: 10.3390/ijerph18094702. PMID: 33925120; PMCID: PMC8125668.

9. Rodríguez Valiente A, Roldán Fidalgo A, Ithzel M. Villarreal, José R, García Berrocal JR. Extended High-frequency Audiometry (9000–20000Hz). Usefulness in Audiological Diagnosis. Acta Otorrinolaringologica (English Edition). Volume 67, Issue 1, 2016. Pages 40-44, https://doi.org/10.1016/j.otoeng.2015.02.001