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Management of Tinnitus in Patients with Presbycusis

Olaf Zagólski

Department of Otorhinolaryngology, Diagnostic and Therapeutic Medical Center, Medicina, Kraków, Poland

Abstract: Sensorineural hearing loss in elderly patients (presbycusis) relatively often coexists with annoying tinnitus (termed *presbytinnitus* [PT] by Claussen). The purpose of this study was to verify the conditions of improvement in patients treated for PT. We fitted with hearing aids 33 PT patients (ages 60–89 years) and questioned them about subjective hearing results. Assessment tools included comprehensive audiology and a subjective self-assessment survey of tinnitus characteristics. All patients had very good tolerance of the hearing aids; 28 reported that they had considerable reduction in PT intensity. Fitting PT patients with hearing aids is usually effective. In patients with unilateral sensorineural hearing loss and tinnitus, fitting the impaired ear is sufficient. Individuals with bilateral complaints require bilateral fitting. Effectiveness of fitting in the affected group of patients depended on speech discrimination scores before fitting. The improvement scores were higher in patients with more aggravated symptoms and did not depend on history of prolonged exposure to excessive noise.

Key Words: elderly patients; presbycusis; presbytinnitus; tinnitus

Sensorineural hearing loss in elderly patients—presbycusis (PC)—results from atrophy of hair cells in the organ of Corti, degeneration of nerve fibers in the cochlear ganglion and the cochlear nuclei, impaired blood supply of the spiral ligament and the vascular stripe, and atrophy of the spiral ligament and rupture of the cochlear duct [1]. Clearly, many individual cases of PC do not constitute a specific type but have mixtures of these pathological types and are termed *mixed PC* [1]. Some 11% of patients with PC complain of annoying tinnitus [2–5], termed *presbytinnitus* (PT) by Claussen [2,6], the term specific for the symptom of tinnitus in aged patients and reflecting cochleovestibular dysfunction [7]. In many cases, the symptom is a stable, high-pitched whistling [8]. The degenerative changes described for PC can be extended for complaints of PT [7].

PT is considered to begin at age 45–55 years, reaching a peak at mid-60 [7]. PT is a significant interdisciplinary therapeutic problem [9]. It may be a sign of dysfunction of either the auditory or other systems (or both) [7]. PT usually occurs in the poorer hearing ear, and PT individuals have a significant reduction in communication skills [7].

The two types of PT are type I, the minority group (in which PT develops as a primary initial complaint in association with a preexisting high-tone sensorineural hearing loss), and type II, the majority group (in which the PT history is long-standing, with a recent exacerbation, significant preexisting sensorineural hearing loss, subjective hearing loss, deterioration in speech discrimination, and significant systemic complaints) [2,6,7]. The management of PT is challenging, and treating physicians need to have a very compassionate attitude toward affected patients. Statements that "there is nothing that can be done" are highly inappropriate and should be avoided [10].

Tinnitus characteristics are assessed using detailed questionnaires [9]. The role of the initial interview in assessing severity of complaints and classifying individuals into appropriate therapeutic groups cannot be overestimated [11].

Relatively many elderly individuals suffering from PT also have different grades of sensorineural or mixed hearing loss; therefore, the aims of sound therapy obtained by tinnitus generators in normally hearing sub-

Reprint requests: Dr. med. Olaf Zagólski, ul. Dunin-Wąsowicza 20/II/9, 30-112 Kraków, Poland. E-mail: olafzag@poczta.onet.pl

jects can be accomplished by fitting with hearing aids those individuals complaining of PT. Properly fitted hearing aids amplify the level of background noise and thus reduce the perception of PT [8,9,12]. The procedure requires thorough explanation of the idea of sound therapy for tinnitus, as many patients with minor sensorineural hearing loss suffer from PT only and are unwilling to wear hearing aids [13]. At the same time, this group of patients is relatively reluctant to accept methods of treatment that require active training and are used in normally hearing patients with tinnitus. However, their expectations of immediate and good therapeutic results are high [13].

OBJECTIVE

The purpose of this study was to evaluate the conditions and patient-based outcome of fitting PT patients with hearing aids. Our particular aims were to assess the impact of such fitting on tinnitus management in the affected group of patients; to decide whether the fitting should be unilateral or bilateral, depending on the character of the tinnitus; and to determine prognostic factors of successful fitting.

PATIENTS AND METHODS

For this study, we chose 33 patients (aged 60–89 years; mean, 71 years; standard deviation, 6.3 years) from a group of 121 elderly patients (aged 60 years or more) who had PC or tinnitus treated in our department. The 22 women and 11 men in this group had never before been fitted with hearing aids. Subjects included in the study were exclusively those who had declared that tinnitus was very annoying to them, at least as much as the hearing loss. Each individual underwent tympanometry, pure-tone audiometry, subjective tinnitus evaluation, uncomfortable-hearing-level assessment, and otoacoustic emission, auditory brainstem response, and speech audiometry (verbal test) recordings. Patients with mixed hearing loss and hyperacusis (subjectively increased sensitivity to sounds, uncomfortable hearing level curve ascending at high frequencies) were excluded from the study.

In evaluating tinnitus characteristics, we asked each patient to compare his or her tinnitus to a pure tone or noise to assess its pitch. Patients evaluated the intensity of tinnitus at the loudness level when the tone or noise stimulating the impaired ear masked the patient's tinnitus.

All patients in the examined group underwent neurological examination and computed tomography or magnetic resonance imaging of the central nervous system to exclude cerebellopontine-angle pathology. We then asked all patients to complete a questionnaire to answer a set of questions concerning the history of their symptoms (the time and circumstances of the onset of complaints), previous treatment, history of exposure to excessive noise, tolerance of loud sounds, character of the tinnitus, circumstances when it was aggravated and subsided, self-assessed hearing, ear diseases, ototoxic treatment, awareness of the tinnitus during the daytime (percentage), scaled loudness, and the impact that the tinnitus had on rest, sleep, and work. We evaluated the intensity of tinnitus and its impact on a patient's life along a scale ranging from 0 to 10. We also questioned the patients about vertigo and other accompanying complaints.

We subsequently fitted all patients with behind-the-ear hearing aids. We then informed them about the use of the fitting according to the character of the complaints and their individual manner of living. Effect evaluation was conducted in a soundproof room immediately after fitting and after a week of wearing the hearing aids. At the follow-up visit, we additionally asked the patients about the number of hours a day that they could comfortably wear the aids and the most common benefits and ramifications of the fitting. We calculated the reduction of tinnitus intensity by subtracting the intensity score obtained after fitting from the score before fitting.

We diagnosed type I PT in 5 patients and type II PT in the remaining 28. We compared results obtained in groups with a tinnitus pitch up to and including 2,000 Hz and above 2,000 Hz; type of the PT; time of complaints (up to 5 years and 5 years and longer); positive and negative history of exposure to extensive noise (at least 5 years' exposure to noise at 90 dB or louder for at least 3 hours per day); age 70 years or younger and age older than 70 years; subjective tinnitus intensity of 40 dB or less and of more than 40 dB, with lowest hearing pure-tone threshold up to and including 4,000 Hz and exceeding this level; and between groups of patients who had speech discrimination below 80% and at or above 80% before fitting. To determine the existence of significant differences between the improvement scores and the variables, we performed an unpaired *t*-test. Subsequently, we calculated Spearman's correlation coefficients to determine whether significant relationships existed between variables.

RESULTS

The duration of patients' complaints varied from 6 months to 20 years. The majority of examined individuals did not remember the circumstances of the onset of their complaints, apart from acute onset in three patients. History of ear diseases was negative in all cases; 18 individuals had been previously treated with oral pira-

cetam, *Ginkgo biloba*, betahistine, or vinpocetine (or both), without result. One patient had been unsuccessfully treated with noise generators; 16 gave a history of prolonged exposure to excessive noise. In all patients, the complaints were aggravated in silent surroundings: 22 patients compared intensity of their tinnitus to sounds at 40 dB and louder. In 21 patients, the tinnitus pitch was equal to or higher than 2,000 Hz. The awareness of tinnitus varied from 20% to 100% of the daytime. Tinnitus had a considerable impact (5 or more points) on rest in 19 patients, on sleep in 17, and on work in 4. Eight patients had speech discrimination scores below 80% in the verbal test performed before fitting. Tinnitus intensity decreased immediately after fitting in 28 patients; 18 did not perceive tinnitus while wearing hearing aids.

We confirmed these results after 7 days during the follow-up visits: 22 patients with bilateral complaints required bilateral fitting, and 11 with unilateral tinnitus were fitted with one hearing aid each. In five patients, the tinnitus attenuated while wearing the hearing aid. All individuals with PT had pathological results of otoacoustic emissions reproduction scores below 70% at the frequency range 2–4 kHz. All patients tolerated the hearing aids very well; 20 with bilateral tinnitus declared "shifting" of the tinnitus toward the unfitted ear while wearing only one unit. An unpaired *t*-test confirmed statistical significance of relationships between improvement scores and the tinnitus intensity before fitting and between improvement scores and speech discrimination scores before fitting. Spearman's correlation was significant for the hearing loss at the tinnitus frequency and intensity of the tinnitus (Table 1).

DISCUSSION

Patients with PT require thorough diagnostic procedures to exclude life-threatening causes of their complaints, and they must be thoroughly informed about results [14]. This information should be presented sensitively and in such a way that it is readily understood by the patient, as tinnitus patients often are afraid of brain pathology that might endanger them [15].

The evaluation of subjective tinnitus intensity is accomplished using a scale, usually ranging from 0 to 10 [13,15]. The scale used in this examination also included questions referring to the influence of the tinnitus on rest, sleep, and work. Elderly patients suffering from intense PT are ready to accept the fitting, even when their hearing is relatively good, which was confirmed in the affected group of patients. Szymiec et al. [10] obtained satisfactory results in PT treatment of 29 persons after fitting them with hearing aids. Also, Nicolas-Puel et al. [8] reported a successful clinical course in 18 patients with PT. Both type I and type II PT exhibit a mild, gradual, progressive hearing loss, demonstrated in audiometry as a downward sloping type of loss [7], which we confirmed in the subject group of patients.

Correlation between hearing threshold elevation scores at tinnitus frequency and tinnitus intensity (in decibels), together with the results of otoacoustic emissions, could confirm that the main defect causing both the PC and the PT sensory component was cochlear damage. The fact that in some patients in this group the improvement was not satisfactory or no improvement accrued could be explained by more complex etiology of the complaints in those individuals.

Table 1. Conditions of Successful Tinnitus Management in the Subject Group

Statistical Test	Variable 1	Variable 2	Statistical Significance
Unpaired *t*-test	Improvement score	History of prolonged exposure to excessive noise	NS
		Type of presbytinnitus	NS
		Tinnitus pitch ≤2,000 Hz and >2,000 Hz	NS
		Age ≤70 yr or >70 yr	NS
		Tinnitus intensity of ≤40 dB and >40 dB	$p < .05$
		Speech discrimination up to 80% or ≥80% before fitting	$p < .001$
		Duration of complaints <5 yr or ≥5 yr	NS
		Hearing loss at frequencies of ≤2,000 Hz and >2,000 Hz	NS
Spearman's correlation	Hearing loss (dB) at tinnitus frequency	Tinnitus intensity (dB)	$p < .001$
	Maximum value of hearing loss (Hz)	Tinnitus pitch (Hz)	NS
	History of prolonged exposure to excessive noise	Tinnitus pitch (Hz)	NS
		Tinnitus intensity (dB)	NS

NS = not significant.

Degenerative changes might have involved not only the cochlea, which was confirmed in otoacoustic emissions recordings, but retrocochlear parts of the auditory pathway (low scores on speech discrimination, which is a very sensitive test for pathologies of the central segments of the auditory pathway) [1]. Shulman observed interference in speech discrimination, particularly in type II PT [7]. In patients with subjectively louder tinnitus, areas of impaired hair cells are most probably wider than in individuals with minor complaints. Background noise supplied by the hearing aids influences a greater number of the hair cells, giving significantly greater improvement in those subjects than in patients with subjectively quieter tinnitus, which was observed in the group of patients under discussion.

Rosenhall [3] proved that a lifetime of exposure to noise is likely to have negative effects on hearing, but determining the interaction between noise-induced hearing loss and age-related hearing loss is difficult. The most commonly accepted assumption is a simple accumulating effect of noise and aging on hearing, particularly on cochlear pathology [3]. However, both a less-than-additive effect and a supra-additive effect have been proposed [3,7]. The absence of difference between results obtained in subgroups of patients with positive and negative histories of prolonged exposure to excessive noise may be explained by the fact that, as in PC, noise-induced damage of the auditory pathway structures is observed most frequently within the cochlea [3]. Ueda et al. [16] noted high-pitched tinnitus (above 4,000 Hz) in both PC and noise deafness. Therefore, if the main functional defect causing tinnitus is dysfunction of the organ of Corti (pathological recordings of otoacoustic emissions, 100% speech discrimination), fitting the patient with hearing aids could be effective for PT.

Podoshin et al. [2] and Rosenhall and Karlsson [17] proved a correlation between the severity of tinnitus and a history of exposure to noise. Our study did not confirm this relationship. Patients with bilateral PT should be fitted with bilateral hearing aids to avoid shifting of the PT toward the unfitted ear, observed in patients with bilateral complaints who wore only one hearing aid.

CONCLUSIONS

The results of this study confirm the effectiveness of fitting the majority of PT patients with hearing aids. In patients with unilateral sensorineural hearing loss and tinnitus, fitting the impaired ear exclusively was effective. Individuals with bilateral complaints required bilateral fitting.

The effectiveness of fitting in the subject group of patients depended on speech discrimination scores before fitting. The improvement scores were higher in patients with more intense tinnitus. The improvement scores and tinnitus characteristics did not correlate with a history of prolonged exposure to excessive noise.

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