Evaluation of Oculomotor Tests in Patients with Tinnitus

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Abstract: Tinnitus as a symptom remains a serious multidisciplinary problem. Vertigo or dizziness is not noticed frequently in tinnitus patients, so vestibular function is not often studied. Because they are in close proximity to one another, the vestibular and hearing organs may influence each other. We decided to evaluate the results of the oculomotor reflex in tinnitus patients. We carried out clinical examinations and audiological and oculomotor tests in 50 tinnitus patients and 30 healthy persons. Such oculomotor tests as smooth-pursuit eye movement, optokinetic tests, and saccadic eye movement and gaze fixation were performed. Tinnitus was unilateral in 37 tinnitus patients (74%) and bilateral in 13 (26%). Twenty-two tinnitus patients (44%) reported previous remote episodes of vertigo and dizziness. Gaze-evoked nystagmus was absent in all cases. Morphological abnormalities and gain decreases in smooth-pursuit tests were recorded in 19 tinnitus patients (38%). Findings in the optokinetic test were incorrect in 10 (20%). The saccadic eye movement test showed disturbances in 18 tinnitus patients (36%). In 11 (22%), abnormal recordings were found in two tests and, in 10 (20%), abnormal recordings were found in all three tests. Our study suggests that computerized, quantitative electronystagmographic analysis in tinnitus patients should be interpreted carefully. A persistence of abnormal oculomotor recordings can suggest subclinical central vestibular system impairment.

Key Words: electronystagmography; oculomotor tests; tinnitus

Tinnitus may be the first and the most important symptom of various diseases. Even when threatening disease is not present, quality of life for the tinnitus sufferer can be seriously impaired. It becomes a significant patient and public health problem. In Poland, permanent tinnitus occurs in 4.8% of patients, according to Polish epidemiological data [1]. Tinnitus is considered as a phantom perception of sound with an unknown site of generation and perception in the auditory system [2]. It seems that there is a hypothetical possibility that abnormalities may arise in the balance system in tinnitus patients, disorders of both a peripheral and a central nature. In the former, it is due to anatomical proximity of the structures of the inner ear; in the latter, some connections between central auditory pathways, cerebellum, and limbic system have been suggested [3–7]. Some type of gaze-evoked tinnitus also has been described, occurring especially after removal of an acoustic neuroma, which may be interpreted as a sign of neuronal plasticity in the auditory system [8]. In our previous examination of the vestibular system in tinnitus patients, almost 50% revealed abnormalities in oculomotor tests that may be interpreted as signs of central involvement [9]. The aim of this study was to clarify this coincidence and to evaluate visuo-oculomotor reflexes in a more precise manner.

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MATERIAL AND METHODS

Our research was carried out in 80 persons, including 48 male and 32 female individuals. They were divided into two groups. The first group consisted of 50 persons complaining of tinnitus that lasted a minimum of more than 3 months; their symptoms were diagnosed at the ear, nose, and throat department of the Medical University of Lodz from 1999 to 2001. Their ages ranged from 21 to 76 years (mean age, 53.5 ± 13.1 years). The second, comparative group was composed of 30 healthy persons aged 21 to 79 years (mean age, 48.6 ± 15.0 years). The patients with middle-ear disorders, central nervous system diseases, and strabismus were excluded. All patients underwent clinical otolaryngological and audiological examination, including pure-tone and speech audiometry, tympanometry, and auditory brainstem response; also neuroradiological imaging, if necessary, was performed. The balance system was evaluated in all by routinely performed electronystagmography (ENG) tests. Oculomotor tests were recorded using a four-channel ENG system (version 2.4, Toennies Nystagliner, Germany) with DC-coupled amplifiers. The evaluative methods used were calibration, spontaneous nystagmus, and gaze-evoked nystagmus (35 degrees left and right of center).

Optokinetic nystagmus was performed using both clockwise and counterclockwise stimuli with a velocity of 28 degrees. In the smooth-pursuit test, subjects followed the target moving at a frequency of 0.3 Hz (28 degrees) and 0.4 Hz (38 degrees) and with amplitudes of 15 degrees right and left. In saccade tests, targets moved abruptly 15 degrees left and right of center. Through computerized quantitative analysis, several parameters were calculated: in the smooth-pursuit test, gain and phase; in optokinetic nystagmus, maximum slow component velocity and velocity preponderance; and in the saccadic test, saccade latency, duration, position, and velocity dysconjugation (i.e., dysmetria and maximum velocity). The morphology of all test recordings was also taken into consideration. The test that produced each initially abnormal result was repeated to achieve optimal performance. Statistic analysis was performed using the Student's *t*-test and the Mann-Whitney test.

RESULTS

The audiological tests revealed that 9 persons (18%) in the tinnitus group had normal hearing, 20 (40%) had unilateral sensorineural hearing loss, and 21 (42%) had bilateral sensorineural hearing loss. Tinnitus was unilateral in 37 patients (74%) and bilateral in 13 (26%). Eighteen patients (36%) reported previous remote episodes of vertigo, and four patients (8%) suffered from dizziness. The previous ENG examination showed signs of vestibular impairment that was peripheral in 1 person, central in 25 (50%), and mixed in 5 (10%). The persons from the control group had hearing within the age-normative range.

Results of the oculomotor tests were as follows: gaze-evoked and spontaneous nystagmus was absent in all cases, but jerk waves were observed in 13 patients from the tinnitus group. The smooth-pursuit test in the 0.3-Hz frequency showed an average gain of 0.76 in the tinnitus group and 0.81 in the control group; in the 0.4-Hz frequency, the average gains were 0.61 and 0.7, respectively. There was no statistically significant difference in mean gain in either group (Fig. 1).

After analysis of all smooth-pursuit test parameters, we found abnormal recordings in 19 persons (38%) in the tinnitus group and in 3 persons (10%) in the control group. These results were statistically significant ($p < .01$). An average phase for the 0.3-Hz and 0.4-Hz frequencies for both groups were within normal range.

For the optokinetic test, the average maximum slow component velocity to the left and to the right in both the tinnitus and the control groups did not differ statistically (Fig. 2). However, there were abnormal recordings in 10 patients (20%) in the tinnitus group and in 1 person (10%) in the control group. This result was statistically significant ($p < .05$).

In the saccadic test, the latency of saccades was 221.2 msec in the tinnitus group and 212.3 msec in the control group; the duration of saccades was 116.8 msec in the tinnitus group and 114.2 msec in the control

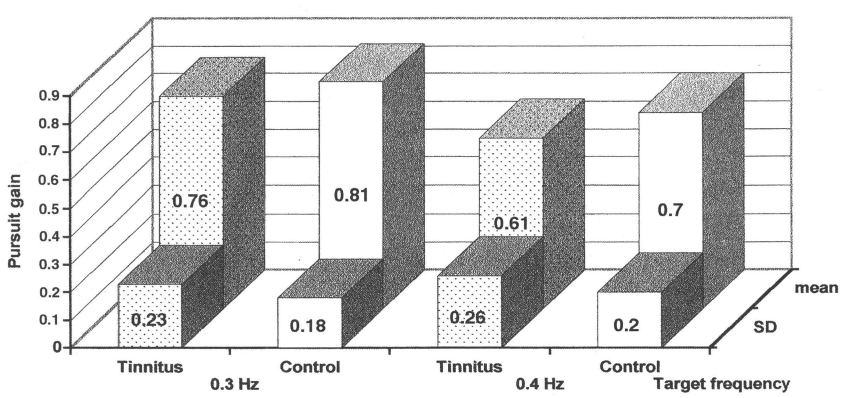

Figure 1. Smooth-pursuit test results in tinnitus and control groups.

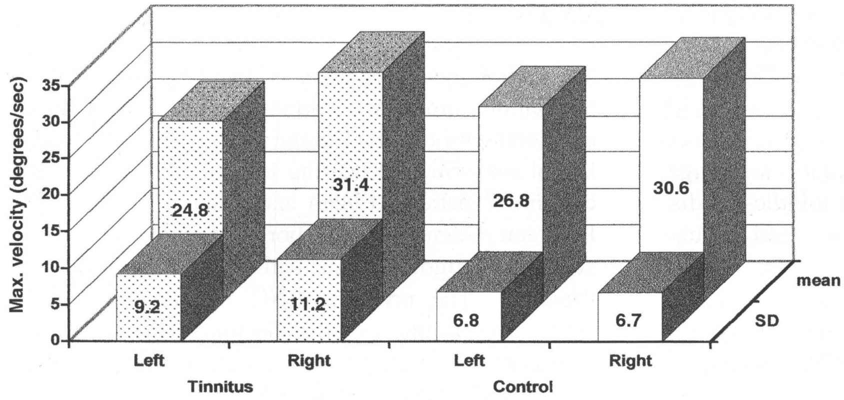

Figure 2. Optokinetic test results in tinnitus and control groups.

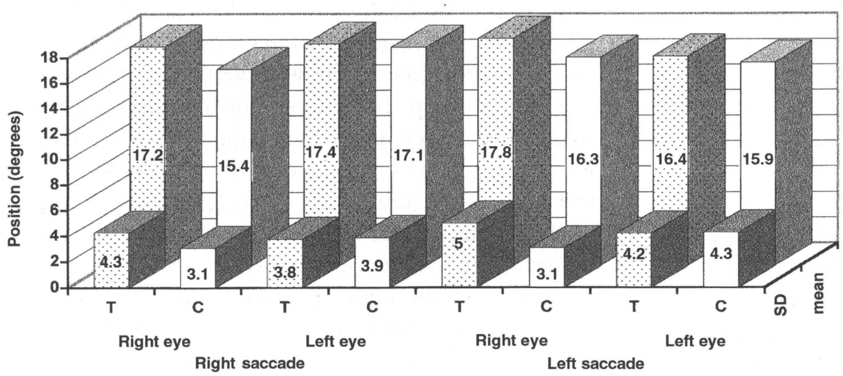

Figure 3. Saccadic test dysmetria results in tinnitus (*T*) and control (*C*) groups.

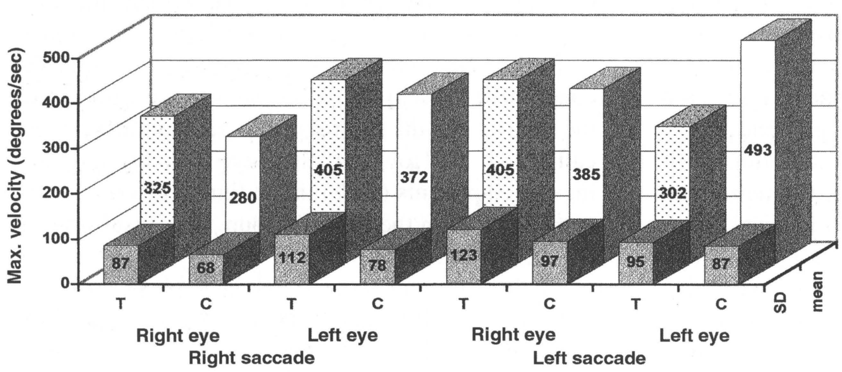

Figure 4. Saccadic test maximum velocity results in tinnitus (*T*) and control (*C*) groups.

group. These average values were not statistically significant for either duration or latency. Average saccade dysmetria was higher in the tinnitus group than in the control group, but these values were not statistically significant (Fig. 3). The mean maximum velocity for the saccades to the right and to the left for both eyes ranged from 302 to 405 degrees in the tinnitus group and from 280 to 493 degrees in the control group. The correlation between mean maximum velocity of saccades was not statistically significant (Fig. 4).

We found abnormal saccade test recordings in 18 tinnitus patients (36%) but in no one in the control group. These results were statistically significant ($p < .001$). In 11 tinnitus patients (22%), abnormalities were found in two or more oculomotor test results. In the control group, incorrect recordings were observed only in single tests.

DISCUSSION

The vestibular system is not often evaluated in tinnitus patients. The predominance of complaints about hearing loss lessens interest in the balance problem in these patients. However, because of their close proximity, the vestibular and hearing organs may influence each other. Only a few authors have dealt with this problem [10–13]. In a multifactor analysis of tinnitus patients, Jakes et al. [10] found vestibular system impairment in only 5% of cases. Conversely, Seabra et al. [14] observed normal ENG recordings in only one-third of patients in a tinnitus group. Similarly, Shulman [4,15] reported that 20% of tinnitus patients complained of vertigo and dizziness and that 60% showed abnormalities on ENG examination. In particular, he demonstrated failure of suppression of the vestibuloocular reflex with eyes open on rotation and abnormalities in the smooth-pursuit test that may confirm central vestibular disorder.

In our study, we found the most frequent abnormalities in smooth-pursuit and saccadic tests both in morphology and in quantitative measurements, although the mean values did not differ statistically from those of the control group. It is difficult to explain why nearly 50% of tinnitus patients had incorrect recordings. It suggests the possibility of abnormal central vestibular system function without neuroradiographically apparent structural changes in tinnitus patients. This is very important, especially in asymptomatic tinnitus patients with vestibular impairment. It may be due also to some psychomotoric features, such as inattention and lack of concentration, which are common in tinnitus patients. Yardley et al. [16] reported that stress may influence the gain of the vestibuloocular reflex. Other authors have observed similar abnormalities in oculomotor tests in several psychiatric diseases without organic lesions, such as neurosis, depression, schizophrenia, and anorexia nervosa [17–20].

Our study suggests that ENG examination results in tinnitus patients should be interpreted carefully. In some cases, repetition of oculomotor tests is necessary to improve optimal performance. Additionally, a use of computerized, quantitative analysis would be helpful in the interpretation of results. A persistence of abnormal oculomotor recordings, which can suggest subclinical central vestibular system impairment, should be pointed out on the bases of a battery of all oculomotor test recordings. Balance system examination is very important in tinnitus patients and requires systematic otoneurological observation.

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