

Electronystagmography Outcome and Neuropsychological Findings in Tinnitus Patients

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Abstract: Because psychological aspects often are underscored in the generation of tinnitus, we assessed the neuropsychological status in our group of patients. We found an increased number of abnormal electronystagmography (ENG) recordings in tinnitus patients. The aim of this study was to compare the ENG outcome with the patients' neuropsychological status. We carried out the study on 69 subjects complaining of tinnitus and on 43 healthy persons. We performed clinical neurootological examinations and ENG tests on all patients. Neuropsychological evaluation was conducted by means of the Beck Depression Inventory (BDI), the Hospital Anxiety and Depression (HAD) test, the Mini Mental Status (MMS) test, and the Trail-Making Test (TMT). In 46 patients (66.6%), we found abnormal ENG outcomes (central, 42%; peripheral, 13.0%; mixed, 11.6%). Neuropsychological tests revealed abnormal scores: for the BDI, 43.5% of patients; for the HAD-A, 72.5%; for the HAD-D, 47.8%; for the MMS, 27.5%; and for the TMT, 55.1%. We did not find correlation between the ENG outcomes and neuropsychological test scores. We did not find correlation between the overall ENG outcomes and neuropsychological test scores, with one exception; we found the occurrence of abnormal neuropsychological test scores and the ENG outcome indicating central vestibular dysfunction. Our study showed that despite a high frequency of vestibular system dysfunction signs and a high incidence of abnormal neuropsychological test scores in tinnitus patients, only one correlation existed between these two results.

Key Words: electronystagmography; neuropsychological evaluation; tinnitus

Psychological aspects and emotional stress are often underscored in the generation and perception of tinnitus, but the mechanisms of tinnitus are still unknown [1,2]. Tinnitus is frequently associated with sensorineural hearing loss but rarely with dizziness or vertigo. In our previous study, we found in tinnitus patients an increased number of abnormal re-

cordings of visuoculomotor tests, which implies central vestibular system impairment [3]. It may be caused by organic lesion or functional disturbances (e.g., anxiety or lack of concentration) often common in these patients [4]. We also decided to assess the neuropsychological status in our group of patients because it contributes to diagnosis and treatment strategies. The aim of this study was to compare the electronystagmography (ENG) outcome in tinnitus patients with their neuropsychological status.

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SUBJECTS AND METHOD

The study, which extended over a minimum of 3 months, was carried out in 69 patients complaining of tinnitus and included 32 males (46.4%) and 37 females (56.6%;

age range, 21–76 years; mean, 52.7 ± 11.8 years). The patients received their diagnoses at the Ear, Nose, and Throat Department of the Medical University of Lodz from 1999 to 2001. Those with middle-ear disorders and central nervous system diseases were excluded. The control group for the ENG tests consisted of 43 healthy persons: 32 males (74.4%) and 11 females (25.3%; ages, 21–78 years; mean, 52.1 ± 17.3 years). In all subjects, we performed neurootological, ophthalmological, and audiological examination, including pure-tone and speech audiometry, tympanometry, auditory brainstem response, and neuroradiological imaging if necessary.

The ENG tests were performed using a computerized four-channel ENG system (version 2.4 Toennies Nystagliner, Würzburg, Germany) with DC-coupled amplifiers. The battery of ENG tests consisted of gaze and positional nystagmus; optokinetic, smooth-pursuit, and saccades tests; a kinetic test with torsion swing; and a caloric test by the Hallpike method. We used both computerized quantitative analysis and individual morphology assessment of all test recordings. The ENG outcomes were evaluated by obvious established criteria, and we classified the site of lesion when two or more abnormal recording results occurred in tests. We applied age-appropriate normative data for the ENG tests. The details of the method were presented in our previous publications [3,5].

We conducted neuropsychological examination by means of four tests. Two—the Beck Depression Inventory (BDI) and the Hospital Anxiety and Depression (HAD) test consisting of two parts (A for anxiety and D for depression)—were to measure functional disorders of the emotional status of patients (e.g., anxiety and depression). The other two tests—the Mini Mental Status (MMS) test and the Trail-Making Test (TMT)—assess cognitive functions (e.g., concentration, information processing, memory, attention, and orientation).

Depending on the degree of symptom severity, scores of tests (especially the BDI and HAD) were ranged in several subclasses—minimal, mild, moderate, or severe—as described in the literature [6–9]. We compared the scores of neuropsychological evaluation with normative data prepared for each test and matched for age, gender, and socioeducational level of patients. Statistical analysis was made using the Chi-square and Fischer tests.

RESULTS

The neurootological assessments showed that tinnitus was more frequently unilateral in 48 patients (69.6%), with unilateral sensorineural loss in 40 patients (58%). Only 21 tinnitus patients (30.4%) had remote episodes of vertigo and dizziness in anamnesis. The profile of patients is presented in Table 1.

Table 1. Neurootological Profile in Tinnitus Patients (n = 69)

Neurootological Symptom	No. of Patients (%)
Tinnitus	
Unilateral	48 (69.6)
Bilateral	21 (30.4)
Hearing	
Normal	9 (13)
Unilateral sensorineural hearing loss	40 (58)
Bilateral sensorineural hearing loss	20 (29)
Vertigo and dizziness	
Episodes in anamnesis	21 (30.4)
Stressing situation (triggering factor in beginning of tinnitus)	9 (13)

Tinnitus patients had significantly more frequent abnormal recording results in the kinetic ($p < .05$), caloric ($p < .001$), smooth-pursuit ($p < .01$), optokinetic ($p < .05$), and saccadic tests ($p < .001$) as compared with those from the control group. No difference was found between those in the tinnitus and control groups for spontaneous nystagmus and positional tests results. In control group subjects, abnormal recording results were observed only in single tests (Fig. 1).

ENG examination results fell in the normal range in 23 tinnitus patients (33.3%). In 46 patients (66.6%), abnormal ENG outcomes were found. Signs of central vestibular system impairment were observed in 29 patients (42%), peripheral impairment in 9 patients (13.0%), and mixed impairment (both central and peripheral) in 8 patients (11.6%).

Neuropsychological tests revealed abnormal scores: for the BDI in 30 patients (43.5%; maximum abnormal, 14.5%); for the HAD-A in 50 patients (72.5%; maximum abnormal, 20.3%); for the HAD-D in 33 patients (47.8%; maximum abnormal, 5.8%); for the MMS in 19 patients (27.5%); and for the TMT in 38 patients (55.1%; maximum abnormal, 43.5%).

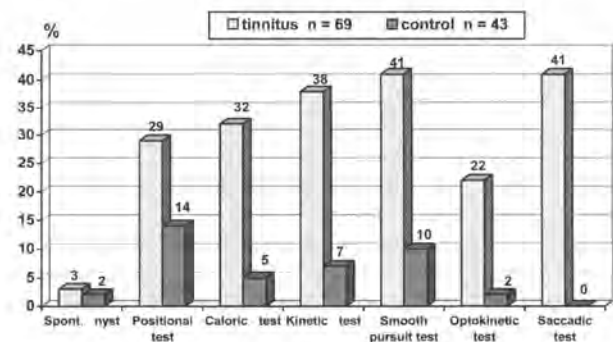


Figure 1. Percentage of abnormal electronystagmography test results in all tinnitus patients (n = 69) and control group subjects (n = 43). (Spont. nyst = spontaneous nystagmus.)

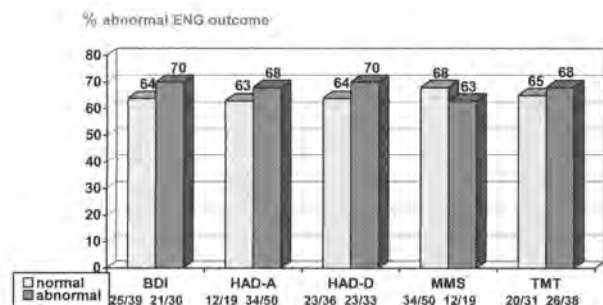


Figure 2. Comparison of abnormal electronystagmography outcomes (n = 46) with neuropsychological test results. (BDI = Beck Depression Inventory; ENG = electronystagmography; HAD-A = Hospital Anxiety and Depression [test]-A; HAD-D = Hospital Anxiety and Depression [test]-D; MMS = Mini Mental Status [test]; TMT = Trail-Making Test.)

In the group of tinnitus patients with abnormal ENG outcomes—central, peripheral, and mixed (n = 46; 66.7%)—distribution of normal and abnormal neuropsychological test scores were similar, so they did not show any statistical difference (Fig. 2).

We also compared abnormal ENG outcomes with normal and maximum abnormal scores of each neuropsychological test, but these were not statistically significant either. In the group of tinnitus patients with abnormal neuropsychological test scores, a percentage of normal and abnormal ENG outcomes was nearly the same, without any statistical correlation (Fig. 3).

In comparing abnormal neuropsychological test scores with ENG test outcomes (normal and those indicating central vestibular dysfunction [n = 37], among which were 29 central and 8 mixed), we found a higher percentage of the signs of vestibular system impairment for only the BDI test (39% vs. 54%; $p < .01$). Other neuropsychological test results did not differ statistically (Fig. 4).

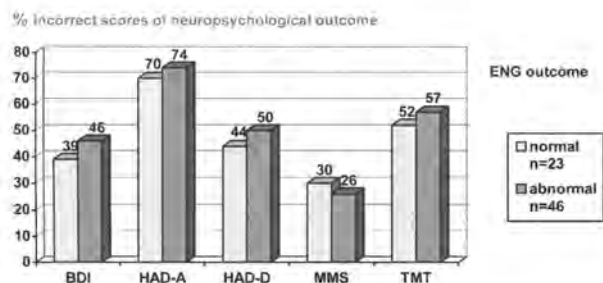


Figure 3. Comparison of abnormal neuropsychological test scores with normal and abnormal electronystagmography outcomes. (BDI = Beck Depression Inventory; ENG = electronystagmography; HAD-A = Hospital Anxiety and Depression [test]-A; HAD-D = Hospital Anxiety and Depression [test]-D; MMS = Mini Mental Status [test]; TMT = Trail-Making Test.)

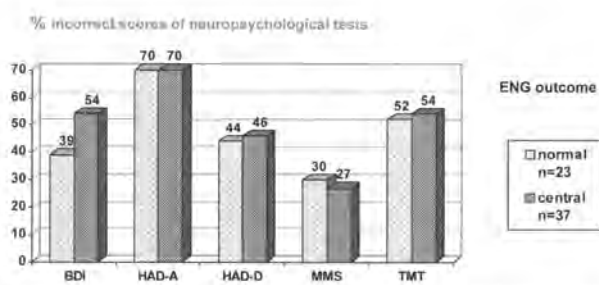


Figure 4. Comparison of abnormal neuropsychological test scores with electronystagmography outcomes indicating central vestibular impairment. (BDI = Beck Depression Inventory; ENG = electronystagmography; HAD-A = Hospital Anxiety and Depression [test]-A; HAD-D = Hospital Anxiety and Depression [test]-D; MMS = Mini Mental Status [test]; TMT = Trail-Making Test.)

DISCUSSION

In tinnitus patients, both this and previous studies revealed a high percentage of abnormal recording results in the ENG tests, despite the fact that only a few patients had complained of vertigo or dizziness [3,5]. This finding coincides with the results of Hallam and Stephens [10], who reported no correlation between objective assessment of balance and the complaint of dizziness. They found that 36% of tinnitus patients had signs of vestibular imbalance in postural tests, although they did not have vestibular symptoms. The majority of the ENG outcomes in our patients imply central vestibular system dysfunction, which was also pointed out by Seabra et al. [11] and Shulman [12].

Psychological factors often are implicated as playing an important role in the processes of perception, interpretation, and treatment of tinnitus and other neuro-otological diseases. McKenna et al. [13] noticed that 42% of neurootology outpatients need psychological help. Their study showed that psychological care was necessary in 64% of patients in their dizziness group, in 45% of patients in their tinnitus group, and in 27% of patients in their hearing loss group. In our patients, we found a high percentage of abnormal scores in neuropsychological tests measuring both emotional distress and cognitive functioning.

The psychological aspect is also mentioned in relation to vestibular symptom manifestation. In patients affected with anxiety, some authors reported enhanced vestibular responses [14–16]. Yardley et al. [14] suggested that this mechanism could be explained by neurophysiological connections between the autonomic and vestibular systems or by anxiety and stress, which may influence the processing of perceptual information. Otherwise, patients with vestibular symptoms are found to exhibit abnormal scores in neuropsychological

examination. Hallam and others [10,17] noticed in a group of tinnitus patients that those with additional dizziness complaints obtained higher scores on an anxiety scale. Vaz Garcia et al. [18] observed different forms of psychopathological manifestations, such as panic disorder, depression, and anxiety, in nearly 60% of patients with vertigo and imbalance.

We would like to study whether this psychological problem in our patients influenced the ENG outcome. Our preliminary study showed that abnormal results of visuoculomotor tests were more correlated with neuropsychological tests measuring cognitive functioning than with emotional distress [19]. In that study, we did not find a correlation between the results of vestibular evaluation based on ENG outcome and neuropsychological status. The only tendency was a prevalence of abnormal scores in one of the tests measuring levels of depression (the BDI test) in patients with a central type of vestibular impairment. Our present study did not confirm previous findings, although we conducted it on a larger group of patients and took into consideration all ENG test batteries, not merely the results of visuoculomotor tests.

In both tinnitus patients and those with dizziness, many factors may contribute to the results of tests for vestibular and neuropsychological examination. Mechanisms of psychological aspects in tinnitus and vestibular dysfunction are still unclear [20], so conclusions should be drawn very carefully to avoid overestimation of ENG outcomes.

CONCLUSIONS

In tinnitus patients, signs of vestibular dysfunction and abnormal neuropsychological test scores are frequently observed. In such patients, abnormal ENG results did not correlate with neuropsychological tests measuring cognitive function and emotional status.

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