Military Institute of Aviation Medicine



Maciej Fus

Retrospective assessment of vestibular organ dysfunction based on nystagmographic examinations in candidates for flight training

Doctoral dissertation for the degree of Doctor of Medical Sciences

Supervisor: dr hab. n. med. Andrzej Wojdas, prof. WIML
Department of Otolaryngology,
Military Institute of Aviation Medicine
Warsaw, Poland

The study was conducted at: *Hearing and Balance Diagnostic Unit,*
Military Institute of Aviation Medicine

Warsaw, 2026

Introduction. Examination of vestibular function is an important element of aviation medicine examinations for candidates for flight training. Their proper function, even above-average efficiency, is essential for maintaining proper aircraft piloting skills. The health requirements placed on pilots are increasingly high. This is a result of the ongoing technological development of highly maneuverable aircraft, and the resulting increased demands on the body during piloting. Symptoms that may occur during flight in individuals with latent vestibular dysfunction pose a significant risk of pilot incapacitation during the flight, leading to a plane crash. Otoneurological diagnostics for aviation cadets is based on nystagmographic examinations as a key element in assessing vestibular function. This allows for the detection of asymptomatic vestibular disorders in cadets, which may constitute a contraindication to flight training.

Aims of the study. This study includes a retrospective assessment of vestibular function in aviation cadets from 2020 to 2022, based on nystagmographic examinations, aimed at:

1. General analysis of the final results of nystagmographic examinations (ENG and VNG), in particular, analysis of the type and frequency of detected abnormalities, taking into account the examination method, gender differences, and differences resulting from age at the time of the examination.
2. Assessment of the results of the caloric test and the rocking chair test as the main components of the nystagmographic examinations (ENG and VNG).
3. Assessment of the frequency of abnormalities in spontaneous nystagmus examinations for the ENG and VNG methods, and abnormal tolerance of the Coriolis test in examinations of candidates for aviation training.
4. General assessment of the validity of nystagmographic examinations for aviation medical certification purposes, identifying key tests and assessing the validity of their repetition or modification.

Materials and Methods. The study included the results of nystagmographic examinations of 1,011 aviation training candidates from 2020 to 2022. ENG and VNG test records were analyzed, with particular emphasis on the results of the swing seat test, caloric test, and Coriolis test.

Results. In the study group, 820 individuals (81%) had normal final test results. Results within the norm within the "limits of permissible variation" were found in 121 individuals (12%), while 70 subjects had abnormal results, representing 7% of the study group. The study noted significantly better results for those tested using the ENG method, with 95% of subjects achieving normal final results. For those tested using the VNG method, normal final results

were found in 91%. In the study group, men achieved better final results (6.5% of abnormal results) compared to women (9.1% of abnormal results). The study found that the best final results were achieved by individuals aged 21 to 24 (94% of normal results). Slightly worse results were achieved by individuals under 21 (93% of normal results). The worst results were observed in individuals aged 27 and older, but it should be noted that the number of individuals in this age group was significantly lower.

The most common reason for a result being considered abnormal, regardless of the testing method, was the presence of abnormal directional predominance of nystagmus [DP] in the caloric test. This abnormality occurred in 40% of abnormal results (37 patients tested using both methods). The second most common abnormality found in nystagmographic tests was the presence of abnormal unilateral weakness [CP] – 36% of abnormal results. The next most common abnormalities were spontaneous nystagmus, which was found in 12% of abnormal results, and a pathological directional predominance of nystagmus in the rocking chair test (TFW) (11% of abnormal results).

Analyzing the most common abnormalities for each test method, it was found that in the case of the ENG method, it was a pathological unilateral weakening of the caloric test (CP) – 33% of abnormal results with this method. In the case of patients examined by the VNG method, the most common abnormality was the presence of a pathological directional predominance of the caloric test (DP) – 51% of abnormal results with this method.

For women, the test that most often led to an abnormal result was a pathological unilateral weakening of the caloric test (CP) in over half of the cases (56% of abnormal results). For men, the most common deficit was the presence of an abnormal directional predominance of the caloric test (41% of abnormal results). In case of some patients with initially abnormal results, who were suspected of having transient vestibular dysfunction, the tests were repeated after several weeks. It was found that, regardless of the testing method, the results improved in most cases. Abnormal results were again obtained in only 17% and 18% of the tests conducted using the VNG and ENG methods, respectively.

This study analyzed the results of the directional predominance of the rocking chair test [TFW] and the CP and DP caloric test, assessing differences in the results depending on the test method, gender, and year of study.

For the directional predominance of the rocking chair test [TFW], no statistically significant difference was found in the distribution of results for all subjects between the ENG and VNG methods. The mean TFW results were higher in women in both the ENG method (7.16% vs.

5.90% in men) and the VNG method (7.34% vs. 6.49% in men). No statistically significant correlation was found between age and TFW results in either test method. When assessing the unilateral caloric test [CP] weakness results, it was observed that the mean percentage of the result for all subjects was over 2% higher in those tested using the ENG method compared to the VNG method. Furthermore, the mean percentage of the CP results was higher in women in both methods, and the results were statistically significantly higher in the VNG method, with the mean CP results being 10.08% in women vs. 8.38% in men. No statistically significant correlation was found between age and the CP results in the ENG and VNG methods.

When assessing the directional predominance of the caloric test [DP] among the subjects, it was found that the mean value of the VNG results was over 2% higher compared to the ENG results (9.27% vs. 7.08%). No statistically significant difference was found between genders or age-related differences in the distribution of DP results for both methods. The 121 individuals with normal results were classified as "within acceptable variability." A higher number of cases occurred in men (93 subjects), but a higher percentage of women achieved this result (17% of women vs. 11% of men). The most common deviation that determined the assignment of the result to the GDZ group was a deviation resulting from a predominance of directional nystagmus [DP] on the caloric test (61% of cases).

Conclusions.

1. Vestibular dysfunction was detected in 7% of aviation candidates. In 5% of those tested using the ENG method and in 9% of those tested using the VNG method. A higher number of abnormal results occurred in women. Those tested using the ENG method achieved better final results compared to those tested using the VNG method. The best results were achieved by individuals aged 21 to 24 years.
2. The caloric test is a key and most selective part of the nystagmographic examination. The most common and leading abnormalities in the examined candidates were the presence of abnormal directional dominance [DP] and unilateral weakness [CP] in the caloric test. The DP and CP results obtained in the caloric test were statistically significantly higher in the VNG method. No statistically significant difference was found between the ENG and VNG methods for the directional dominance of the swing chair test.
3. The mean value of the results obtained by all the examined candidates for the directional dominance of the swing chair test [TFW] and the unilateral weakness parameter of the caloric test [CP] was higher in the examined women compared to the examined men. However, no gender differences were found for the DP results of the caloric test.

4. There was no correlation between the candidate's age at the time of the examination and the values obtained in the caloric test and the swing chair test parameters in both nystagmographic methods.

5. Twice as many people with latent spontaneous nystagmus were detected during ENG testing. 6. Results rated as "within the acceptable variability" were found in 12% of the candidates tested. These results are considered within normal limits and should not exclude candidates from flight training.

7. ENG and VNG testing remain key and equivalent methods in the otoneurological diagnosis of LAW candidates.