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ORIGINAL STUDY

Comparative analysis of the data obtained in computerized posturography and videonystagmography for patients with peripheral vestibular deficit

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ABSTRACT

BACKGROUND. Vestibular disorders are a group of widely spread diseases that have as a common denominator the disturbance of the equilibrium system. The assessment of vestibular disorders consists in a complex examination of the patient including a thorough anamnesis, a rigorous clinical examination and multiple functional explorations.

OBJECTIVE. To asses weather there is a correlation between the data obtained in posturography and those obtained in the videonystagmography in patients with peripheral vestibular disorders.

MATERIAL AND METHODS. Collecting data from the observation sheets of patients diagnosed with peripheral vestibular syndrome and examined in the Department of Otorhinolaryngology of the "Sfanta Maria" Hospital in Bucharest over a period of 18 months.

RESULTS. We analyzed a number of 97 cases of patients diagnosed with peripheral vestibular disorder. A large number of patients (49) had correlated changes in the caloric tests and also in the posturography. A second group of patients (43) had changes in caloric tests but with no changes in posturography. The third group of 5, paradoxically, had a vestibular deficiency in posturography associated with normal caloric reactivity.

CONCLUSION. The results obtained with the videonystagmography are correlated with those of the caloric and rotational videonystagmographic tests in the case of acute vestibular diseases. In chronic vestibular diseases, it is possible to find caloric vestibular paresis in the presence of a normal posturography. The "vestibular omission" is a phenomenon in which the patient does not use the vestibular input of a normal labyrinth with caloric and rotary tests within normal limits. As no vestibular examination can be considered as self-staging diagnosis, we always have to establish the final diagnosis correlating the results of all the tests available.

KEYWORDS: computerized posturography, videonystagmography, caloric and rotational testing, vestibular compensation, vestibular omission.

INTRODUCTION

Vestibular disorders are a group of disorders that have as common denominator disturbances of the static and/or dynamic balance. Vertigo, dizziness and unsteadiness are common symptoms with an important prevalence in the general population. In a population-based study performed in north-eastern France, the 1-year prevalence for vertigo was 48.3%, for unsteadiness 39.1% and for dizziness 35.6%[1]. The site of the generating lesion may be at the level of nervous centers in the central nervous system or at the peripheral level, in the internal ear. The topography of the lesion divides vestibular disorders into peripheral vestibular syndromes and central vestibular syndromes. Each of these types of vestibular syndromes is clinically expressed through a series of characteristic signs and symptoms that allow for their identification. For the diagnosis of the patients with vestibular syndromes, it is required that they undergo three stages of examination: anamnesis, clinical examination and functional vestibular exploration[2].

The history of the disease is the most important of the three stages. There are anamnesis data collected regarding the comorbidities, the onset of the disease, trigger factors, type of vertigo (dizziness or true vertigo?)[3].

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The clinical examination focuses on the effect of the vestibular disorder on the vestibular-ocular reflex (VOR) and the vestibular-spinal reflex (VSR). Eye movements, mainly nystagmus, and segmental and truncal deviations are observed. Peripheral vestibular nystagmus is characterized by the fact that it has two unequal phases (the fast phase that gives the sense of nystagmus and beats toward the more active ear); it is inhibited by ocular fixation; it is more intense when the patient looks in the direction of the rapid phase and has an opposite sense to segmental and truncal deviations.

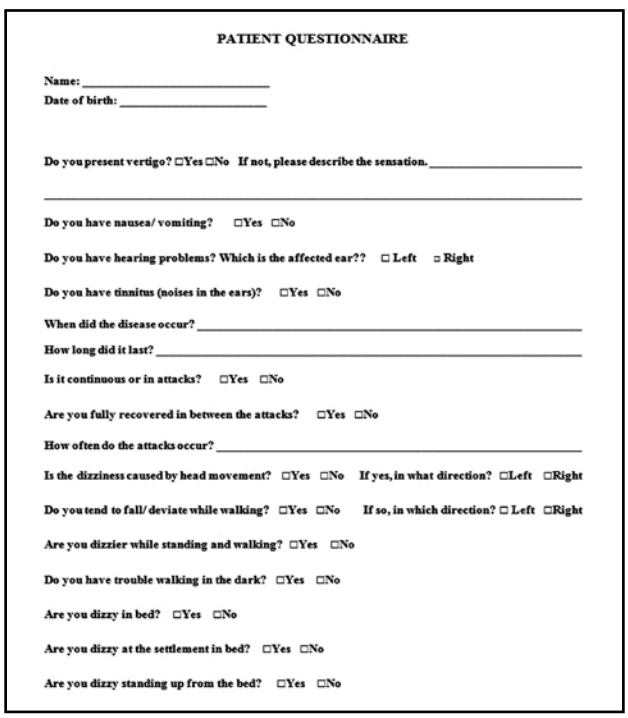
Many clinical tests are used in the examination of the patient with vertiginous syndromes. The most commonly used in everyday practice in bedside examination are: examining spontaneous and positional nystagmus, head shaking nystagmus (HST), head impulse test (HIT), Romberg's test, Fukuda (Unterberger)[4]. Vestibular functional exploration is based primarily on electro/video-oculography that makes the computerized analysis of eye movements, and therefore studies changes in RVO[5,6], and on computerized posturography that practically investigates changes that occurred in the vestibulo-spinal reflex.

Computerized dynamic posturography (CDP) analyzes the movements of the weight center of an individual evaluated under different conditions: open eyes, closed eyes, "sway-referenced" vision, on a stable platform or on a sponge that changes proprioception. There are 6 conditions of examination. The way the test is designed makes it possible to study the manner in which the patient organizes the maintenance of balance using the vestibule, vision and proprioception. The result of the posturographic test highlights the way the patient uses the three vestibular inputs, quantifying the overall balance and each of them separately. Changes can be quantified showing the decrease in the vestibular, visual or somesthesic input. There is also the possibility of highlighting the existence of a visual dependence characterized by the use of the vision in particular to maintain the balance at the expense of the other inputs[7,8].

Video-oculography or videonystagmography (VNG) is a computerized analysis of eye movements. The spontaneous nystagmus is studied by measuring the speed of its slow phase and its amplitude. The influence of visual fixation on nystagmus and its variation after HST is also studied. Eye movements are studied during oculomotricity tests as smooth pursuit, saccade, optokinetic nystagmus or gaze-nystagmus. The effect of different head positions is studied and the positioning test Dix-Hallpike is performed. The anomalies of the nystagmus caused by the caloric or rotational stimulation of the vestibular system are used to determine the functionality of the vestibular system. The positioning test establishes the degree of reactivity of the vestibular system to different stimuli, caloric or rotational, and draws conclusions about the functioning of the vestibular system[9,10].

MATERIAL AND METHODS

We performed a retrospective study by analyzing the data from the observation sheets of patients diagnosed with peripheral vestibular syndrome and examined in the Department of Otorhinolaryngology of the "Sfanta Maria" Hospi-



PATIENT QUESTIONNAIRE

Name: _____
Date of birth: _____

Do you present vertigo? ☐Yes ☐No If not, please describe the sensation. _____

_____

Do you have nausea/ vomiting? ☐Yes ☐No

Do you have hearing problems? Which is the affected ear?? ☐ Left ☐ Right

Do you have tinnitus (noises in the ears)? ☐Yes ☐No

When did the disease occur? _____

How long did it last? _____

Is it continuous or in attacks? ☐Yes ☐No

Are you fully recovered in between the attacks? ☐Yes ☐No

How often do the attacks occur? _____

Is the dizziness caused by head movement? ☐Yes ☐No If yes, in what direction? ☐Left ☐Right

Do you tend to fall/ deviate while walking? ☐Yes ☐No If so, in which direction? ☐ Left ☐Right

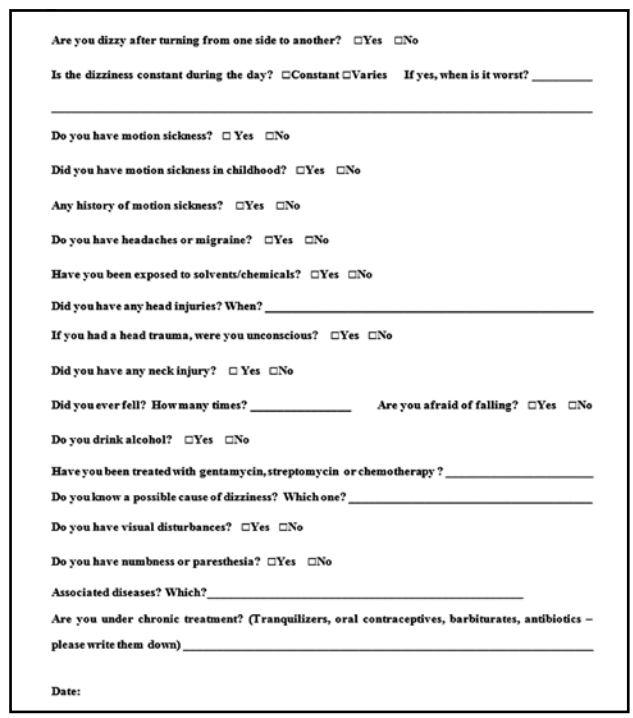
Are you dizzier while standing and walking? ☐Yes ☐No

Do you have trouble walking in the dark? ☐Yes ☐No

Are you dizzy in bed? ☐Yes ☐No

Are you dizzy at the settlement in bed? ☐Yes ☐No

Are you dizzy standing up from the bed? ☐Yes ☐No



Are you dizzy after turning from one side to another? ☐Yes ☐No

Is the dizziness constant during the day? ☐Constant ☐Varies If yes, when is it worst? _____

_____

Do you have motion sickness? ☐ Yes ☐No

Did you have motion sickness in childhood? ☐Yes ☐No

Any history of motion sickness? ☐Yes ☐No

Do you have headaches or migraine? ☐Yes ☐No

Have you been exposed to solvents/chemicals? ☐Yes ☐No

Did you have any head injuries? When? _____

If you had a head trauma, were you unconscious? ☐Yes ☐No

Did you have any neck injury? ☐ Yes ☐No

Did you ever fell? How many times? _____ Are you afraid of falling? ☐Yes ☐No

Do you drink alcohol? ☐Yes ☐No

Have you been treated with gentamycin, streptomycin or chemotherapy ? _____

Do you know a possible cause of dizziness? Which one? _____

Do you have visual disturbances? ☐Yes ☐No

Do you have numbness or paresthesia? ☐Yes ☐No

Associated diseases? Which? _____

Are you under chronic treatment? (Tranquilizers, oral contraceptives, barbiturates, antibiotics – please write them down) _____

Date:

Figure 1 Anamnesis questionnaire.

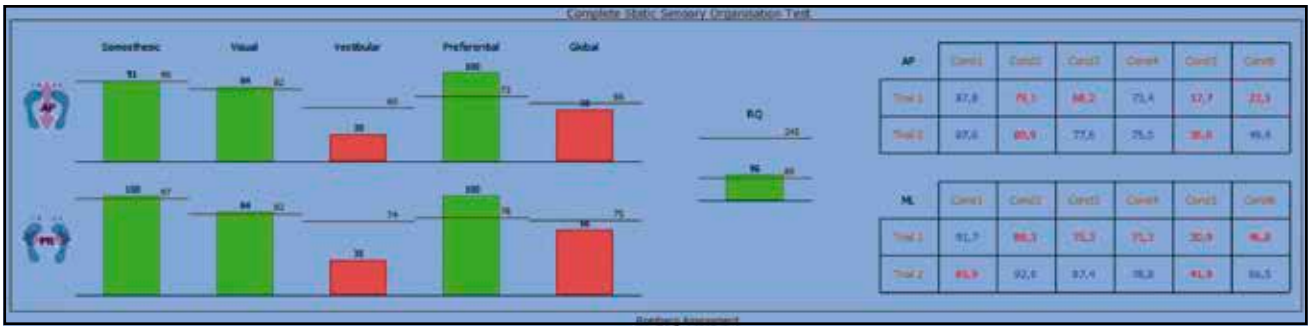


Figure 2 Result of a SOT with a decrement in the global vestibular score with a vestibular pattern; notice the important decrement in the vestibular input.

tal in Bucharest over a period of 18 months, between January 2017 and May 2018.

We collected data from the anamnesis, the clinical examination and the functional explorations: CDP and VNG with caloric and rotational tests.

The diagnostic algorithm applied to all patients with vestibular diseases in our clinic consists of:

1. The patient completes a questionnaire by means of which the anamnesis data are collected (see questionnaire in Figure 1);
2. ENT clinical examination with audiogram and impedancemetry;
3. Clinical vestibular examination, including examination with Frenzel video glasses;
4. Functional Vestibular Exploration: CDP, VNG with caloric and rotational tests.

The vestibular clinical examination consisted in making and marking the observations in the medical records of the following tests: Romberg, Fukuda, HST, HIT, positional tests, slow tracking, saccade, vibration-induced nystagmus (VIN). Diagnosis of the peripheral vestibular syndrome is based on the corroboration of anamnesis data, the results of the vestibular clinical examination that highlights a peripheral vestibular syndrome and the paraclinical exploration results. For the computerized posturography we used a Synapsys system (France).

Data obtained from the SOT (sensory organization test) were taken into account. This test consists of examining changes in the position of the center of gravity of the subject in 6 conditions of examination: open eyes, closed eyes, with "sway-referenced vision" on a stable and on an unstable plane. The results of the test are represented by the measurement of the different sensory inputs that help maintain balance and they are expressed in a graph, such as Figure 2.

The decrease in the overall vestibular score below 66 at the anterior-posterior deviations and a 75-point score at medial-lateral deviations, and lowering the vestibular score below 60 to the antero-posterior deviations and below 74 at medial-lateral deviations are considered pathological.

Videonystagmography was performed using an Interacoustics system (Denmark), with OtoAccess software. Spon-

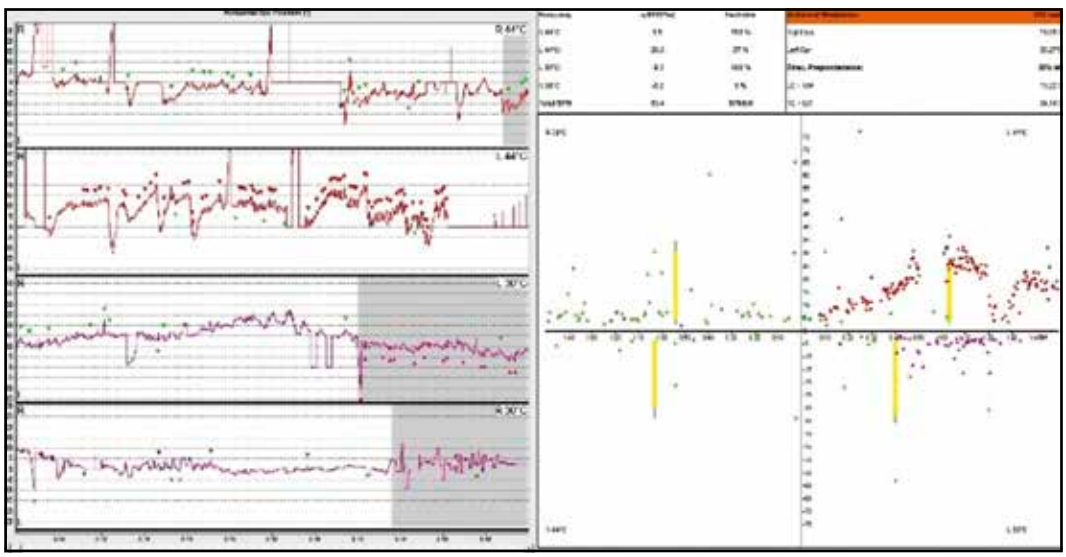


Figure 3 Results of a caloric test with a right vestibular areflexia. Notice the presence of the left spontaneous nystagmus (in green). It is the case of a patient with acute vestibular neuritis.

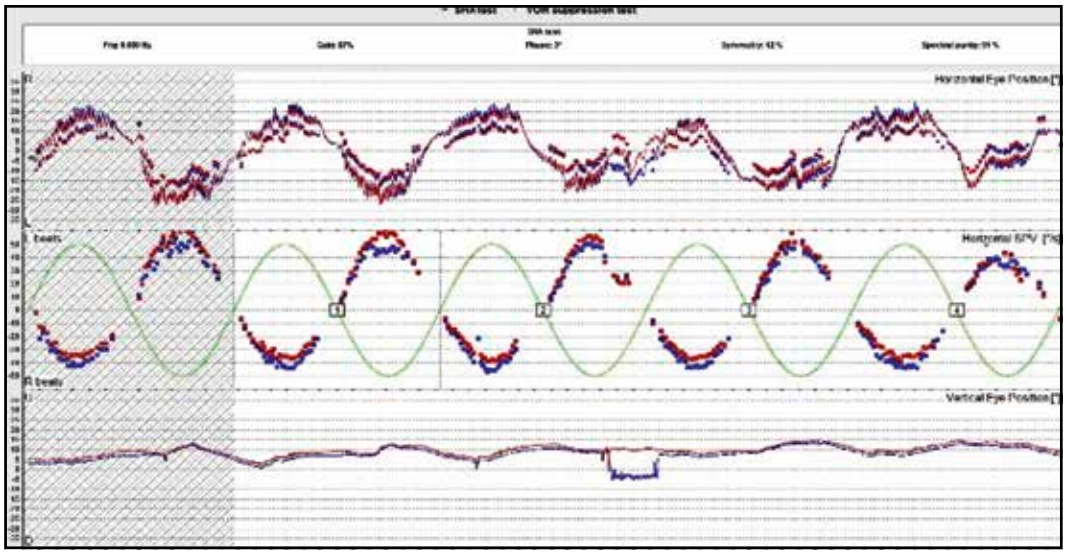


Figure 4 Graph of a normal sinusoidal harmonic acceleration test.

taneous nystagmus, oculomotricity tests, positional tests, caloric and rotational tests were recorded. Caloric testing was performed using hot water irrigation of both ears at temperatures of 30 and 44 degrees Celsius. It is considered significant to determine a unilateral vestibular deficiency – a difference between the caloric reactivity of the two ears greater than 25%. For illustration see Figure 3.

The rotary tests used to assess the patients were sinusoidal harmonic acceleration and step rotation. The asymmetry of the results between the two parts was considered an indicator of peripheral deficit. The low gain and phase lead was also considered abnormal, showing an uncompensated peripheral deficit. In Figure 4, a normal sinusoidal harmonic acceleration graph is illustrated.

RESULTS

During the period considered in our study, we examined 97 patients diagnosed with peripheral vestibular deficiency. We took into account general data such as sex, age, duration from the onset of the disease, and data obtained in the computerized posturography and at the caloric and rotational testing from videonystagmography.

In the first stage of our study, we analyzed only the results of the posturography and the data obtained at the caloric testing in the VNG. For an easy statistical interpretation of the data, in the first stage of our study, we noted with "1" the modification observed in the caloric test from videonystagmography (VNG-caloric testing) or posturography (CDP) and with "0" no change. Three groups of patients have been identified in this way and that can be synthesized as follows in Table 1.

Analyzing the table obtained, it was observed that a large number of patients (49) had changes in caloric tests and also in the posturography and the data collected were consistent with a vestibular deficiency. A second group of patients (43) presented changes in caloric tests – a caloric paresis, so they were diagnosed with peripheral vestibular disease but they had no changes in posturography. The third group, paradoxically, had a vestibular deficiency in posturography (in the sensory organization test they had a low vestibular score with a vestibular deficit pattern) associated with normal caloric reactivity.

In the next stage of the study, the data obtained for the patients in each of the three categories were analyzed, observing the duration of the disease and the results obtained

Table 1
The VNG-caloric testing and CDP results in the study groups ("1" – a modification was observed; "0" - no change).

	VNG-caloric testing	CDP	Number of patients
Group 1	1	1	49
Group 2	1	0	43
Group 3	0	1	5

at the video-oculography. The videonystagmographic tests that were considered were: spontaneous nystagmus and rotatory tests.

Group 1

49 patients: 37 women and 12 men; average age 42 years, with a standard deviation of 20.6 years; 40 with unilateral deficit, 9 with bilateral deficit.

The diseases that have generated the peripheral vestibular deficiency were: acute vestibular neuritis (29), acute labyrinthitis (1), Meniere's disease (1), labyrinthine artery stroke (1), presbystasis (9), idiopathic vestibular disease (2).

The mean duration since the onset of the disease that generated the vestibular deficiency: 2 weeks.

The presence of spontaneous nystagmus was noticed at videonystagmography in 39 of the 49 patients. Rotatory tests demonstrated asymmetry, gain decrease and/or phase lead in 42 out of the 49 patients.

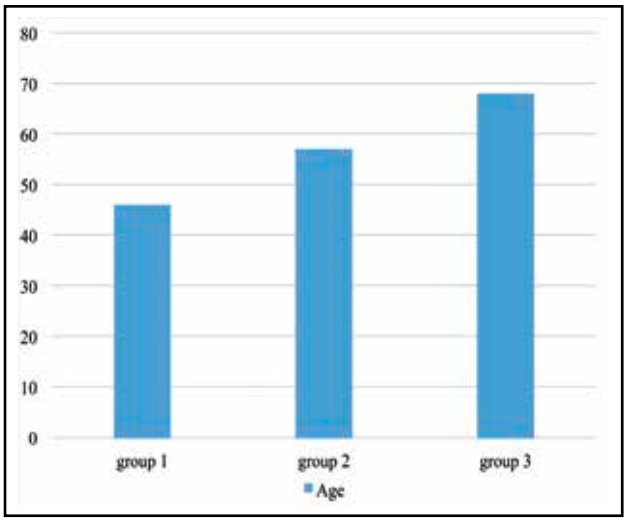


Chart 1 Comparison of patients' age in the three groups.

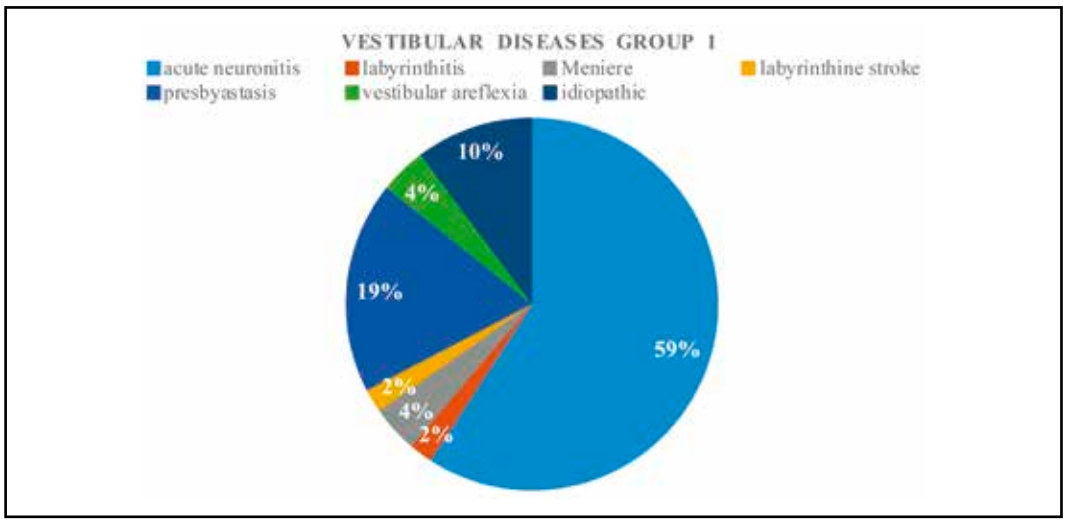


Chart 2 The vestibular diseases in group 1.

Group 2

43 patients: 32 women and 11 men; average age 57 years with a standard deviation of 11.6 years; 41

with unilateral deficit, 2 with bilateral deficit.

The diseases that generated peripheral vestibular deficiency were: compensated vestibular neuritis (32), Meniere's disease (5), recurrent vestibulopathy (2), idiopathic vestibular disease (4).

The mean duration of the disease that generated the vestibular dysfunction: 42 weeks.

Spontaneous nystagmus was recorded in 1 out of 43 patients; the rotational tests showed changes in 2 patients in this group.

Group 3

5 patients: 4 women and 1 male; average age 68 years.

Period from the onset of the disorder: 4 weeks.

The diseases that generated the peripheral vestibular deficiency were: presbystasis (2), VPPB (2), idiopathic vestibular disease (1). Without spontaneous nystagmus at VNG and no change in rotary evidence.

DISCUSSIONS

Analyzing the data obtained from the patients in our study, we noticed the following aspects:

The predominance of female sex was noted in all three groups. Comparing the age of the patients in the three groups, it is observed that patients in group 1 are younger compared to the other two groups of patients (Chart 1).

Comparing the etiology of the diseases that caused the peripheral vestibular deficiency, we noticed that in group 1 we have more patients with acute vestibular neuropathy (vestibular neuritis) compared to group 2. It is also ob-

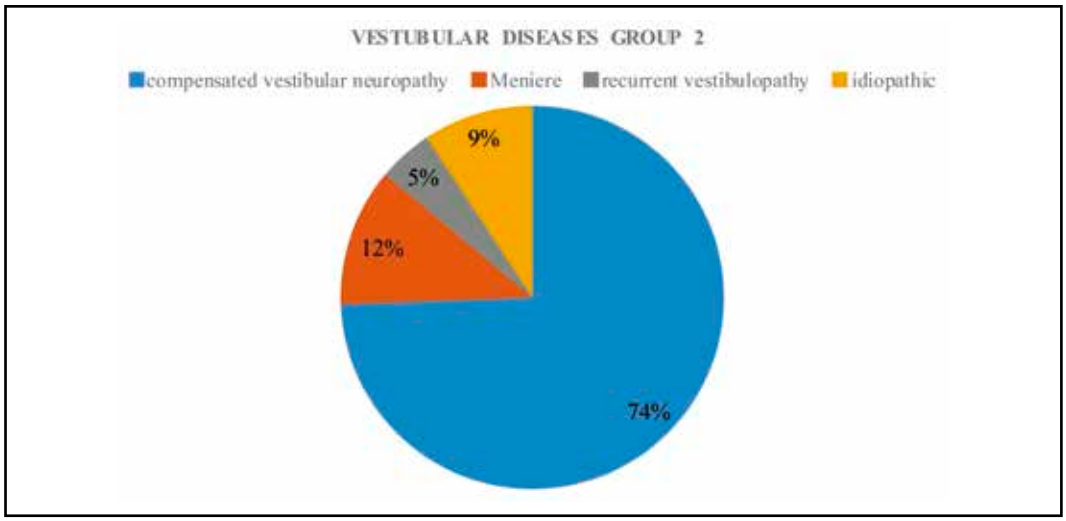


Chart 3 The vestibular diseases in group 2.

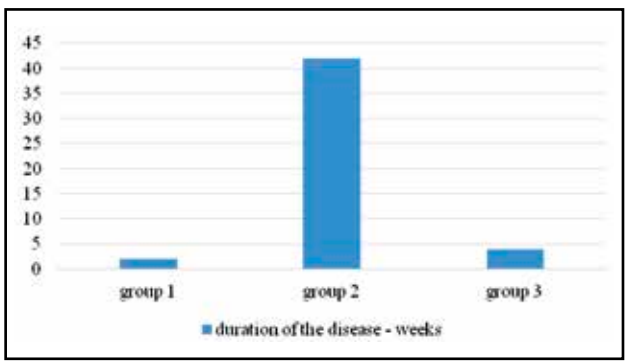


Chart 4 The duration of the disease (weeks).

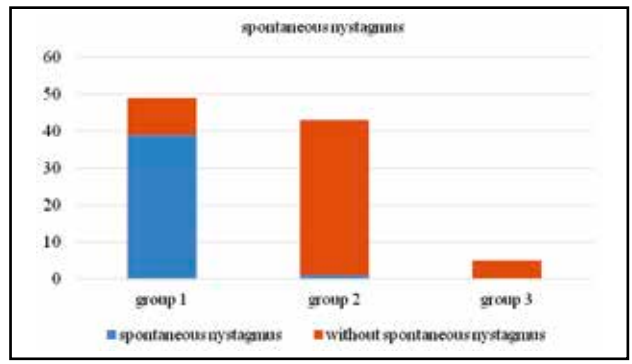


Chart 5 The spontaneously recorded nystagmus in videonystagmoscopy.

served that patients in group 1 had acute conditions compared to the other two groups (Charts 2, 3).

Analyzing the duration from the onset of the disease to the time of the examination, we notice that the average duration is higher in group 2, where chronic diseases are predominant (Chart 4).

If we analyze the presence or absence of spontaneously recorded nystagmus in videonystagmoscopy, we notice that the majority of patients in group 1, who also suffered from peripheral vestibular diseases with acute evolution, also had spontaneous nystagmus compared to those in group 2 who, for the most part, did not have spontaneous nystagmus (Chart 5).

The changes observed in rotational tests were generally asymmetry and gain decrease. These changes were predominant in group 1 of patients (Chart 6).

The analysis of the obtained data shows that the patients in group 1 had changes in posturography as well as in videonystagmography, with the presence of spontaneous nystagmus and alterations of caloric and rotational tests; they were diagnosed predominantly with acute vestibular diseases. In group 2 of patients, who showed

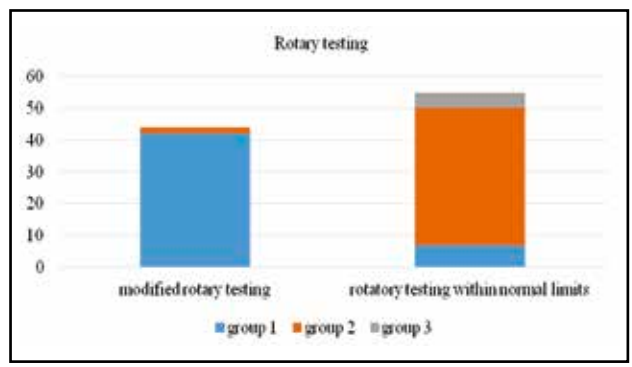


Chart 6 Rotational tests results.

changes in caloric testing but without alterations in computerized posturography, we generally diagnosed chronic vestibular diseases with long evolution in which the vestibular compensation process occurred. We note that this group of patients had fewer changes in rotational testing, indicating that the vestibular compensation had occurred. Group 3 of patients, who had no changes in rotational and caloric tests, but had changes in computerized posturogra-

phy, demonstrating a patent vestibular deficit with 0 or extremely small vestibular score, is the most interesting group in which we diagnosed the phenomenon of "vestibular omission". An apparently healthy labyrinth with caloric and rotational tests within normal limits is not used to maintain the balance due to a history of a vestibular disorder that has led to the neglect of this input[11].

CONCLUSIONS

The results obtained with the videonystagmography are correlated with the results of the caloric and rotational videonystagmographic tests in the case of acute vestibular diseases, in which we find the decrease in the vestibular score at CDP, but also the caloric paresis and the decrease in the vestibular gain and asymmetry in rotational testing.

In the case of chronic vestibular diseases where vestibular compensation has already been established, it is possible to find caloric vestibular paresis in the presence of a normal posturographic result.

We should not forget about the possibility of a "vestibular omission" phenomenon in which the patient does not use the vestibular input of a normal labyrinth with caloric and rotary tests within normal limits.

The vestibular functional investigations have the role of validating the data obtained through the vestibular clinical examination and documenting the changes obtained. The diagnosis of the vestibular patient should be considered in a global manner; the data obtained at each stage (i.e. anamnesis, clinical examination and paraclinical examinations) should be correlated and coordinated so as to obtain a coherent result that explains all the manifestations of the patient. There is no vestibular examination that can be considered as self-staging diagnosis; we always have to establish the final diagnosis correlating all the results of all the tests available.

Conflict of interest: The authors have no conflict of interest.

Contribution of authors: All authors have equally contributed to this work.

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