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Research Article

Vestibular System Evaluation: Results on Analysis of Videonystagmography in Persian Adults

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Abstract

Background and Aim: Falls are one of the major problems in the elderly and are considered one of the "Geriatric Giants". Recurrent fall is an important cause of morbidity and mortality in this segment of the population and is a marker of poor physical and cognitive status. The aim of the present study is to compare the VNG (Videonystagmography) test results in adults with and without falls history.

Method: 60 adults (30 with one or more falls history and 30 without any falls history) above 65 years old performed the VNG subtests included saccade, gaze, smooth pursuit, positional nystagmus, spontaneous nystagmus and caloric at rehabilitation faculty of Tehran University of Medical Sciences.

Results: According to the data 74% of the faller group showed abnormal performance in the caloric subtest and more than 60% had abnormal results in the saccade, gaze and smooth pursuit subtests too.

Conclusion: The non- faller group had better performance than the faller group in all of the subtests which indicates better vestibular system status in this group. According to the results, VNG performance can help guide the clinicians in the development of a safe exercise program, it means that the exercises that can be offered through classes or individually. Exercise programs can be offered in a community setting, at home with supervision or in a program that combines group classes or one- on-one training with home- based exercise.

Keywords: VNG; Falls; Adults

Introduction

Fall among older adults is a major health problem [1]. Approximately 30% of the adults over 65 years old fall each year and the incidence is higher for persons 75 years or older [2].

Falls are one of the major problems in the elderly and are considered one of the "Geriatric Giants". Recurrent falls is an important cause of morbidity and mortality in the elderly and is a marker of poor physical and cognitive status [3].

The consequences of falls are one of the main causes of independence loss in this population. Someone with a history of previous falls has a two-thirds chance of having a fall in the future [4,5].

Multiple falls can cause physical injuries such as fractures or head injuries leading to functional incapacity, increased risk of nursing home admission and higher mortality rate [6].

There is a constant concern among health professionals to prevent the consequences of fall in geriatric health. Thus, several instrument models have been developed for the early detection of those with the greatest risk of falls [7]. An extensive range of tests has been developed for use in the clinical setting, one of the clinical tests which evaluates peripheral and central vestibular system and can be used as a tool to predict risk of fall in the elderly is the VNG test. The VNG has become the "gold- standard" assessment of the integrity of semicircular canal function. This test consists of a set of subtests that evaluate ocular motor subsystem integrity (e.g. saccadic, smooth pursuit, optokinetic sub systems), search for evidence of positional or positioning-induced vertigo and evaluate the symmetry of function of the right and left lateral semicircular canals.

Vestibular system disorders can be divided into the two types: first, the peripheral vestibular system impairments and second, the central vestibular system impairments. The symptoms of the peripheral vestibular system impairments includes: nystagmus with fixed direction, horizontal nystagmus or nystagmus which is suppressed with fixation. The symptoms of the central vestibular system impairments include: direction changing nystagmus, purely vertical nystagmus and the nystagmus which is present even with fixation [1,8,9].

This investigation was conducted to compare the VNG results in the elderly with and without fall history.

The aim of the present study is to compare the VNG test results in adults with and without falls history.

Material and Method

A sample of 60 subjects with a mean age of 70 years (± 5 years) was studied. Of the sample, 30 subjects had one or more falls history (faller group) and 30 subjects had no falls history (non- faller group). The study was performed at rehabilitation faculty of Tehran University of Medical Sciences. All of the subjects were evaluated in the early morning and the assessment required 1-1.5 hours to complete. To

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rule out any abnormality of the external auditory meatus, otoscopic examination was done before the beginning of the study. To assess the peripheral and central vestibular system, VNG test was conducted by following:

- Saccade subtest
- Gaze subtest
- Smooth pursuit subtest
- Positional nystagmus subtest
- Caloric subtest

Saccade subtest

The ability to move the eyes in a rapid single movement to refixate a target of interest onto the fovea. The types of the saccade test abnormalities include: disorder of saccade velocity (too slow, too fast), disorders of latency or timing and also accuracy (overshoot, undershoot, glissade, pulsion and so on) [10].

Gaze subtest

The ability to maintain gaze stable without the generation of other eye movements while looking straight ahead, left, right, up and down [10].

Smooth pursuit subtest

The ability to track the movement of a target of interest maintaining the image on the fovea with smooth continuous eye movements as opposed to tracking with the use of repeated saccades [10].

Positional nystagmus subtest

In this subtest, the patient is placed in as many as 10 positions and eye movement recordings are conducted for 20 to 30 seconds in each position [10].

Caloric subtest

Caloric irrigations administered in the supine position with the head placed at an angle of 30 degrees with respect to the horizontal plane [10]. In this study, we used warm and cold air as irrigation.

The SPSS v19 software package was used for statistical analysis. In the comparative analysis, Levene's test of homogeneity of variances was used, as was the Kolmogorov- Smirnov test to evaluate the degree of normality of the continuous variables. The analysis of the variance (ANOVA) was used to examine the relation among independent quantitative variables. In those cases in which statistical significance was detected, post hoc tests or orthogonal contrast studies were performed to compare the different groups among each other. Pearson's correlation coefficient was used to establish relations between quantitative variables. Sample differences were considered to be statistically significant when $P<0.05$ and they were considered to be highly significant when $P<0.01$.

Results

Each group (patient and control group) was made up of 15 men and 15 women. Of the patient group, 18 (60%) had one history of fall and 12 (40%) had more than one history. None of the members of the control group had a fall history. Mean age of the two groups was 70(± 5 years). Mean age, age range and history of fall are shown in Table 1.

Table 1: Baseline demographic and fall history data.

	Patient group		Control group	
	normal	abnormal	normal	abnormal
Saccade subtest	30%	70%	90%	10%
Gaze subtest	25%	75%	95%	5%
Smooth pursuit subtest	35%	65%	95%	5%

Table 2: Gaze, saccade and smooth pursuit subtest scores which is related to central vestibular system ($p<0.05$).

	Patient group	Control group
Mean age	70(± 5 years)	70(± 5 years)
Range of age	65-75	65-75
Fall history	1 or more	0

The control group achieved better scores than the patient group in all of the subtests. According to the data of the patient group, the members who suffered from central vestibular disorders had worse function than the others who suffered from peripheral vestibular ones. Central vestibular impairments were verified by encephalic magnetic resonance.

Table 2 shows gaze, saccade and smooth pursuit subtest scores which is related to central vestibular system ($p<0.05$).

When the total bithermal caloric test slow phase eye velocity (SPV) exceeded 25degree/sec, a unilateral weakness was defined as a left/right asymmetry. When the total bithermal caloric test SPV exceeded 30degree/sec, a directional preponderance was defined as an asymmetry in left beating versus right beating caloric responses. A bilateral weakness occurred when the total caloric SPV was ≤ 12degree/sec.

Table 3 shows the total caloric response, the percent of unilateral weakness and the percent of directional preponderance on the bithermal caloric test.

According to the above table, the faller group showed unilateral weakness (47%) but the magnitude of the directional preponderance of both groups is in the normal range (3% and 10%). It is obvious that all of the caloric test measures were significantly different between the two groups.

Discussion

The aim of the present study was to compare VNG test parameters between adults with and without fall history. Of the faller group only 12(26%) demonstrated normal performance. Neither of the groups showed DP but UW was out of normal range in the faller group.

A review of the existing literature has shown that subject samples chosen to evaluate the relationship between vestibular system impairment and falls have varied widely. Herdman et al. (2000) chose to study a sample of all patients evaluated in their clinic who had unilateral or bilateral vestibular impairments (i.e., the sample was not solely patients referred for falls risk) [11].

Table 3: The results of caloric test in faller and non faller groups.

Group	Right warm caloric max SPV	Left warm caloric max SPV	Right cool caloric max SPV	Left cool caloric max SPV	UW (%)	DP (%)
Non faller	26	21	22	20	8	3
Faller	39	9	25	14	47	10

Kristinsdottir et al. (2000 and 2001), Pothula et al. (2004) and Murray et al. (2005) studied patients who had sustained injuries requiring medical treatment or hospitalization [1,12,13]. Whitney et al. (2006) studied patients referred to both balance disorders and falls risk clinics [9].

Herdman et al. (2000) evaluated falls history in a sample of all patients seen at their clinic who had unilateral and bilateral peripheral vestibular system impairments determined from bithermal caloric test [11].

They reported that those patients who had unilateral vestibular system impairments demonstrated a greater falls risk than patients of equivalent age in the general population [11]. The difference was 51% for patients versus 25% for the general population in the 65–74 year age group. Of the sample 65 years of age with bilateral impairments, 15% experienced falls requiring medical attention. The investigators reported that patients with unilateral impairments were more likely to have multiple falls than those with bilateral impairments (i.e., 38% of patients with unilateral impairments versus 21% of patients with bilateral impairments) [11].

Murray et al. (2005) evaluated 20 patients (mean age 78 years, 75% female) who had sustained a fall that required medical treatment. These patients were age and sex matched to a group of subjects who had not fallen in at least the last 12 months. The authors reported that although there were no significant group differences in reports of dizziness, the group of fallers demonstrated significantly poorer performance on condition 5 of the Clinical Test of Sensory Inter action on Balance (CTSIB), which is sensitive to the presence of vestibular system impairment [1].

Pothula et al. (2004) employed a vestibular symptom questionnaire to determine the presence and severity of vestibular symptoms that occurred in the 12 months period prior to an unexplained fall that required treatment in an emergency room. Subjects were 428 patients (mean age: 72 years; 1:2.4 ratios of men to women). The authors reported that 80% of these patients had symptoms of vestibular system impairment [13].

In a recent study, Whitney et al. (2006) reported their findings obtained from a group of 100 patients referred to a balance and falls clinic. The sample contained non fallers (n 5 70), one-time fallers (n 5 13), and recurrent fallers (n 5 17). This was a younger cohort than that of other studies (mean age: 59 years 617 years). In this sample, quantitative vestibular function tests were performed (i.e., caloric testing, ocular positional tests and rotational tests). The investigators reported that there was no relationship between quantitative evidence of peripheral vestibular system impairment and falls. That is, the control subjects were found to have evidence of peripheral vestibular system impairment as often as patients who had a history of one or more falls (9).

A key question is, "how might vestibular system impairments contribute to postural instability and falls?" It is our feeling that the contributions may be both direct and indirect. Direct effects occur in the acute stages of a vertiginous episode. Direct effects also can occur long after a unilateral vestibular impairment has occurred when it is severe enough to cause changes in the timing of the VOR. When this occurs, a head movement (e.g., in the yaw axis) when gaze is fixed on a point, can result in smearing of the visual image. Indirect effects may occur when preexisting "mild" visual and somatosensory system impairments become "unmasked" when an impairment of the vestibular system (i.e., the third inter dependent sense for spatial orientation) occurs.

In summary, the data in the present study showed that peripheral and central vestibular system impairment may be an under-appreciated contributor to postural instability and falls in the elderly.

According to the results, VNG performance can help guide the clinicians in the development of a safe exercise program, it means that the exercises that can be offered through classes or individually. Exercise programs can be offered in a community setting, at home with supervision or in a program that combines group classes or one-on-one training with home- based exercise. Appropriate types of exercises that effectively reduce falls in older adults include:

- Tai Chi
- Strengthening exercises combined with balance training

Balance exercises [14].

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