

Evaluation of balance with video head impulse test and vestibulospinal tests in patients with substance use disorder

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Abstract

Aim: The aim of this study was to investigate the long-term complications of substance use on the vestibular system. Substance use disorders are thought to impair the vestibular apparatus as well as the auditory system.

Materials and Methods: Sixty-five cases with a history of non-alcohol drug addiction who survived the withdrawal phase and 22 healthy controls were included in the study. The cases were categorized into 2 different subgroups as those who had used only opioids ("opioid") and those who had used an opioid and chemical simultaneously or otherwise ("opioid & chemical"). Vestibulospinal tests and video Head Impulse Test (vHIT) were performed on all participants and the results were analyzed.

Results: A total of 65 (61 males/4 females, mean age was 25 ± 3.95 years) cases and 22 (males, mean age was 25 ± 3.3 years) healthy controls were included in the study. The mean age of the "opioid" group (n=33) was 25 ± 3.95 years, and the mean age of the "opioid & chemical" group (n=32) was 25 ± 3.13 years ($p > 0.05$). When the cases and controls were evaluated according to vestibulospinal tests, a high level statistically significant difference was observed ($p < 0.001$), but no significant difference was found according to vHIT.

Conclusion: This is the first study evaluating long-term vestibular functions with the vHIT test in patients with substance use disorder. Although the results suggest that there is no vestibulo-ocular reflex (VOR) involvement in the groups according to the vHIT, it has been revealed that substance use has negative effects on balance and walking.

Keywords: Balance; substance use disorders; vestibulospinal tests; video head impulse test

INTRODUCTION

Drug addiction remains a growing problem in Turkey as well as in the whole world. The decline of the starting age of substance use is also one of the main concerns. Substance use is a dynamic problem and adversely affects many areas of life, including work, education, family and social relationships (1,2). It is well known that substance use has many harmful effects on the human body, especially on the neurological system. One of the important affected areas is the vestibulocochlear system. The auditory system and the vestibular system have many common anatomical and physiological points. Studies have suggested that substance use may affect the vestibular system as well as the auditory system (3). Substance use causes widespread brain stem disorders and compromises the transmission of auditory stimuli. In addition, it is thought that the cerebellar system is both

involved in the pathogenesis of substance addiction and may be affected by addiction (4). In this study, we aimed to reveal the long-term side effects of substance addiction on the vestibular system by evaluating individuals with a history of substance abuse and a healthy control group with the vestibulospinal tests (Romberg's test, Unterberger's test, and gait analysis) and video Head Impulse Test (vHIT). We also tried to test the vestibular side effect potential of the type of substance used.

MATERIALS and METHODS

Patient Selection

Between February and September 2018, 70 cases diagnosed with non-alcohol substance use disorder according to DSM-5 criteria in Ankara Numune Hospital Alcohol and Substance Addicts Treatment Center (AMATEM) and 22 healthy controls were included in the study. Individuals in the withdrawal phase were not

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included, as they could not comply with the tests due to withdrawal symptoms. Five cases were excluded from the study due to pregabalin use (n=4) and a diagnosis of schizophrenia (n=1). Inclusion criteria for both groups were no history of hearing loss, balance disorder, visual impairment, neurological, musculoskeletal, and cardiac disease, no drug treatment at least 48 hours before test, and no alcohol use. Besides, the cases were categorized into 2 different subgroups as those who had used only opioids ("opioid") and those who had used an opioid and chemical simultaneously or otherwise ("opioid & chemical").

Balance Tests

Vestibulospinal tests (Romberg's test, Unterberger's test, and gait analysis) and vHIT (InteracousticEyeSeeCamvHIT, Denmark) tests were performed on all participants. In Romberg's test, participants were asked to stand with feet together and arms at their sides. If they were stable while open-eyed, participants were secured and asked to close both eyes. Being able to maintain an upright posture without swaying or falling for 30 seconds was evaluated as negative and if not being able to do so, the test was considered positive. In the Unterberger's test, participants were asked to undertake stationary stepping for one minute with their eyes closed. A positive test was indicated by the rotational movement of the patient. During gait analysis, after the participants walked 3-4 meters on a treadmill, they were run on the same line blindfolded. The result was accepted as positive in cases of swaying with closed eyes or inability to walk. In the vHIT test, all participants were seated on a chair 1.5 m from the wall, and a circle was drawn on the wall at eye level for fixation. The glasses of the device were tightly worn and arrhythmic and irregular head movements were performed on the patients. Normal limits for vestibulo-ocular reflex (VOR) gain was accepted ≥ 0.8 for the left lateral (LL) and right lateral (RL), and ≥ 0.7 for left anterior (LA), right anterior (RA), left posterior (LP), and right posterior (RP) semicircular canals (SSC). Vestibular involvement was investigated with a decrease in VOR gain and the presence of overt/covert saccades.

Statistical Analysis

The data were analyzed using SPSS (Statistical Package for Social Sciences) 23 for Windows package program. Descriptive statistical data were presented as mean \pm SD, median (minimum-maximum), frequency, and percentage distribution. T-Test and One Way Analysis of Variance were used for the analysis of 2 and 3 independent groups, respectively. Pearson Chi-Square Test and Fisher's Exact Test were performed in the analysis of categorical variables. The relationship between variables was evaluated by the Spearman Correlation Test. The Mann-Whitney U test was used for paired comparisons made with Bonferroni correction to determine the source of the statistical significance between the 3 groups. Statistical significance level was accepted as $p < 0.05$.

RESULTS

A total of 65 (61 males/4 females, mean age was 25 ± 3.95 years) cases and 22 (males, mean age was 25 ± 3.3 years)

controls were included in the study. The mean age of the "opioid" group (n=33) was 25 ± 3.95 years, and the mean age of the "opioid & chemical" group (n=32) was 25 ± 3.13 years ($p > 0.05$). The average duration of substance use was 3.6 ± 1.64 (min 2, max 16) years in the "opioid" group, 3.7 ± 2.01 (min 2, max 14) years in the "opioid & chemical" group ($p = 0.533$).

In all three of Romberg's test, Unterberger's test, and gait analysis, a high level statistically significant difference was found between the cases and controls ($p < 0.001$). However, no difference was found between the "opioid" and "opioid & chemical" groups in all three vestibulospinal tests ($p > 0.05$) (Table 1). When evaluated with the vHIT test, all steps of the test were found to be negative in all participants and there was no statistically significant difference between the groups. The average asymmetry values of the lateral, LARP, and RALP SSC by groups are presented in Table 2.

Table 1. Comparison of the vestibulospinal test results of the study groups

Tests	"Opioid" (n=33)	"Opioid & Chemical" (n=32)	Control (n=22)	p value
Romberg's test				
Positive	25(76%)	22(69%)	0 (0%)	<0.001
Negative	8(24%)	10(31%)	22(100%)	
Unterberger's test				
Positive	25(76%)	23 (72%)	0(0%)	<0.001
Negative	8(24%)	9(28%)	22(100%)	
Gait analysis				
Positive	21(64%)	23(72%)	0(0%)	<0.001
Negative	12(36%)	9(28%)	22(100%)	

Table 2. The mean VOR gain asymmetry values of lateral, LARP, and RALP semicircular canals by groups

Semicircular canals	"Opioid" Mean \pm SD	"Opioid & Chemical" Mean \pm SD	Control Mean \pm SD	p value
Lateral	3.79 \pm 2.26	3.41 \pm 2.42	3.50 \pm 2.30	0.79
LARP	3.54 \pm 2.40	3.53 \pm 2.17	3.50 \pm 2.20	0.99
RALP	3.73 \pm 2.01	3.87 \pm 2.45	3.73 \pm 2.19	0.96

DISCUSSION

This study investigated the long-term vestibular functions in patients with substance use disorder. We found that patients with substance use disorder had more vestibulospinal dysfunction than controls. But there were no differences between "opioid" and "opioid & chemical" groups. In our study, the mean age of the group with a history of substance use was 25 ± 3.95 years. In some studies conducted in AMATEM before, the average age was found to be higher than our study (5,6). According to published data, it has been determined that the age of substance use is getting smaller and hospital admissions

are made at an earlier age due to increased healthcare services for substance addiction treatment (7). In our study, the male to female ratio in the substance user group was observed to be 15.25:1. In many studies conducted in the field of alcohol and substance addiction, the ratio of male to female was reported range from 11:1 to 30:1 (8,9).

A lot of neurological symptoms encountered in patients with substance use disorder due to both the effect of substance use and withdrawal. Many studies have been conducted examining the effects of single or multiple substance use on hearing (10-12). In these studies, it was revealed that patients also had vestibular dysfunction such as dizziness and balance disorder (3). However, studies investigating the existence of permanent vestibular pathologies in individuals with a history of substance abuse are quite limited.

The vestibular system works together with the eyes and the proprioceptive system to maintain body balance. Integration of these three systems occurs in the vestibular nucleus. Vestibulospinal tests are reliable tools for evaluating postural performance and should be interpreted considering the age of the patient (13,14). In our study, a significant long-term vestibular dysfunction was found in patients with substance use disorder according to vestibulospinal tests. These results suggest that opioid or multiple substance use may cause permanent pathologies in the vestibular system.

One of the techniques widely used in the clinical evaluation of the peripheral vestibular system is the vHIT test recently. vHIT is known as a practical method for the differential diagnosis of peripheral vestibulopathy and central nervous system disorders. An abnormal VOR or a positive vHIT is interpreted in favor of acute peripheral vestibulopathy. Under normal circumstances, if the head is pushed to one side while looking at a target, the eyes continue to look at the target. This occurs when the eyes move in the opposite direction and at the same speed as the head movement. This compensatory movement of the eyes is provided by the stimulation of the lateral SSC on both sides and the activation of the disynaptic VOR system. This system forms the basis of vHIT. Many studies have been conducted investigating the effect of opioid drugs on the vestibular system with vHIT. Lehnen et al. were tried to explain the mechanism of nausea and vomiting complications of remifentanil used in the treatment of pain in healthy individuals with the help of the vHIT. As a result of their study, it was determined that remifentanil reduces VOR gain and it was recommended that strong head movements should be avoided to prevent nausea and vomiting caused by the substance (15). Our study is the first study evaluating long-term vestibular involvement in patients with substance use disorder with the vHIT test. We performed vHIT on individuals with a history of substance abuse and healthy controls to evaluate their peripheral vestibular systems. In our study, no differences were found between the groups in the results of vHIT, and it was observed that peripheral

vestibular pathologies were not encountered in subjects who stopped substance use and were purified. Therefore, it may be said that detoxification treatment eliminated the negative effects on VOR, or substance use may not have an effect on VOR all the way. Hence, this issue can be explained with a vHIT study to be conducted during the substance use period.

The function of the cerebellum is also important in maintaining balance. The cerebellum is one of the main modulatory organs that affects and is affected by addiction. Especially, structures of the posterior cerebellar hemispheres such as hemispheric lobule VI and Crus I play a prominent role (16). Preclinical, neuroimaging, and clinical data suggest that cerebellar changes may both predispose and play an important role in the course of addictive disorder (17). As a matter of fact, vestibular tests were not found different from healthy people in this study. However, a problem was detected in other balance tests including the cerebellum. In all three of Romberg's test, Unterberger's test, and gait analysis, while it is different from healthy controls, the lack of difference in vHIT test, which is a vestibular test, suggests that the balance problem may arise from the cerebellum, not the vestibular system. Information from the vestibular system may go to the cerebellum, but the equilibrium processes in the cerebellum may not function well.

LIMITATIONS

This study has some limitations. First, low number of the participants especially for controls, second, there was any other chemical used but its types were not defined. Not including the duration of substance use, the small number of participants, and being the single-center study can also be listed among the limitations.

CONCLUSION

As a result, although it was seen that there was no VOR effect in the groups evaluated according to vHIT results, it was revealed that the use of opioids and/or chemicals have a negative effect on balance and walking. Studies to be conducted with more participants with long-term follow-up are needed to determine the VOR exposure better. It may be useful to evaluate vestibular functions during treatment course of patients with substance use disorder.

Competing Interests: The authors declare that they have no competing interest.

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