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Comparison of Video Head Impulse Test Results of Pediatric Patients with Dizziness with Healthy Volunteers

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ABSTRACT

Objective: The Video Head Impulse Test (V-HIT) is a non-invasive diagnostic test that evaluates the functions of the semicircular canals separately. This test records eye movements in response to head movements, and the vestibulo-ocular reflex gain (VOR-G) is calculated. V-HIT is frequently used in diagnosing adult patients and has been increasingly used in children in recent years. Indeed, V-HIT measurements may be useful in the diagnosis, especially in pediatric patients where vestibular pathologies are difficult to evaluate. In this study, V-HIT findings of pediatric patients with dizziness were examined, and the results were compared with healthy volunteers.
Methods: Thirteen pediatric patients who applied to our clinic with dizziness and nine healthy children were included in the study. The necessary evaluations and radiological imaging were performed, and children diagnosed with any pathology were excluded. Each patient underwent GN Otometrics ICS Impulse V-HIT examination, and the results were recorded. The Video Head Impulse Test (v-HIT) results of children with vertigo were compared with those of healthy volunteers and analyzed.
Results: The mean age of the patients included in the study was 10.5±3.5 years (range: 5-16). Five of these children were boys, and 8 were girls. In the control group, there were five girls and four boys, and their mean age was 9.3±3.9 years (range: 5-16). None of the children had any additional disease. When the groups were compared, the left anterior canal and left lateral canal VOR-Gs were significantly different between the patients and healthy volunteers (p=0.027 and p=0.007, respectively). No statistically significant difference was observed between the groups in terms of the right anterior canal, right lateral canal, left posterior canal, and right posterior canal VOR-G measurements (p=0.928, p=0.738, p=0.588, and p=0.780,).
Conclusion: V-HIT, a non-invasive method for evaluating the etiology of vertigo in children, can be easily applied even in very young children. The use of glasses suitable for children will facilitate the procedure.

Keywords: Video head impulse test, Video Head Impulse Test, dizziness in children, vertigo

INTRODUCTION

Childhood dizziness has a prevalence of 8% to 15%, and its etiology is usually different from that in adults. It is not easy for a child to describe dizziness, and physical examination is also challenging in children. Therefore, it is more challenging to diagnose pediatric cases than adults, and vestibular tests come to the fore in evaluating vertigo and dizziness in this patient group (1).

The main vestibular tests used for the evaluation of children are video electronystagmography (VENG), cervical vestibular-evoked myogenic potential (cVEMP), ocular vestibular-evoked myogenic potential (oVEMP), caloric test, rotatory chair, and video head impulse test (V-HIT), the use of which has increased in recent years (2).

V-HIT is a relatively new technique used in the diagnosis of dizziness. This technique can measure the functions of six semicircular canals (SCC) separately (3). Eye movements in

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response to head movement are recorded by a camera installed on eyeglasses that can record high-speed motion. This is called vestibulocular reflex gain (VOR-G) (3, 4).

Compared to VENG, cVEMP, oVEMP, and caloric test used in diagnosing dizziness, V-HIT, which is simpler to apply in children, provides information about all SSCs, unlike the former that mainly give information about lateral SCC. Since V-HIT is a non-invasive test, its applicability is higher in the pediatric age group (5).

Children put on glasses with a camera placed on the right side and are asked to look at a fixed point. During this procedure, VOR-G is recorded while head movements are made by following a sequence. The V-HIT test is frequently used in adults, and many studies have been conducted on normal V-HIT values in this patient group. However, studies on the pediatric patient population are lacking (5-8).

In this study, we aimed to evaluate the applicability of the V-HIT test in the pediatric patient group and V-HIT findings in pediatric patients with dizziness.

MATERIALS AND METHODS

This study was conducted on both healthy volunteers and patients who applied to the Otolaryngology Clinic of a private tertiary care hospital for dizziness between 2019 and 2022.

Ethical Board Approval

This study was approved by Acıbadem University and Acıbadem Healthcare Institutions Medical Research Ethics Committee (ATADEK) (Date: 25.03.2022, No: 2022-06/11).

Study Design and Participants

In this study, two groups of pediatric populations were evaluated with V-HIT. Medical records of pediatric patients with dizziness were reviewed retrospectively, and healthy volunteer children with parental consent were invited to the study for the V-HIT test as the control group.

The patients included in the study were evaluated with the diagnostic criteria of chronic idiopathic dizziness. Patients with normal neurological and ENT examinations in addition to a non-vertiginous imbalance condition were evaluated to see if they met the criteria. Patients were included in the study if 3 of the following 5 conditions were present: dizziness with the feeling of swaying; light-headedness; subjective unsteadiness during standing and/or walking; something wrong in the head; a feeling of a disturbance of balance. As a time criterion, patients whose dizziness had been present at least 8 days per month for the previous 3 months were included.

The children with dizziness underwent routine otolaryngology and head and neck examinations, and audiological evaluations were also conducted. These children were also evaluated by a pediatric neurologist, and contrast-enhanced inner ear and cranial MRIs were taken. Neurological and vestibular examinations of the children in the patient group were normal. Children detected with hearing loss in pure tone audiometry and children with any pathology detected in cranial and ear MRI were excluded from the study. Nine children in the control group had no symptoms, and their vestibular examinations were normal. V-HIT was applied to all children, and the results were recorded.

Sixteen pediatric patients were evaluated for inclusion in the study. One patient was excluded from the study because of labyrinth inflammation in the MR imaging, and two patients were excluded because they could not comply with the test. After those patients were excluded, the study continued with 22 participants, including 13 children who were evaluated retrospectively in the patient group and 9 children in the control group.

Statistical Anylasis

SPSS 24.0 was used for statistical analysis. The “Shapiro-Wilk test” was used for the distribution and normality of the data, and the “Independent Samples t Test” was used to compare the VOR-G mean values of both groups, and the significance level was determined as $p<0.05$.

Video Head Impulse Test

Tests were performed in a well-lit test room using the V-HIT Otometrics ICS Impulse (A/S Taastrup, Denmark) instrument. Before the test, participants and parents were informed. First, the subject was asked to keep their head still, and calibration was performed with the help of laser lights displayed around an object placed 1m away. Then, the participant was asked to follow a sinusoidally moving target with head movements, and thus the calibration control was performed. Following the completion of the calibration, the subject was asked to lock their gaze on a target object and to keep it fixed on the object even if the operator moved the subject’s head. All tests were conducted by a single operator. During the test, the operator made random movements of the patient’s head 10-20 degrees in all three planes. To test the vertical channels, the subject’s head was made to move 30 degrees to the right or the left. The same settings were used for each test (8). The device processes all the data and outputs the information separately for each SSC as a graphic output (Figure 1).

RESULTS

Of the 22 children included in the study, 13 were girls, and 9 were boys. The mean age of the children included in the study was 10±3.6 years. In the patient group, 5 of the children were boys, 8 of them were girls, and their mean age was 10.4±3.5 years. The mean age of the children in the control group was 9.3±3.9 years, and 4 of the children in this group were boys, and 5 were girls. None of the children had any additional disease (Table 1). The mean VOR-G values in the patient group were as follows: left anterior canal mean VOR-G value: 0.75±0.07 (0.64-0.92); right anterior canal mean VOR-G value: 0.85±0.15 (0.65-1.12); left lateral canal mean VOR-G value: 0.77±0.09 (0.56-0.88); right lateral canal mean VOR-G value; 0.96±0.14 (0.75-1.34); left posterior canal mean VOR-G value: 0.86±0.16

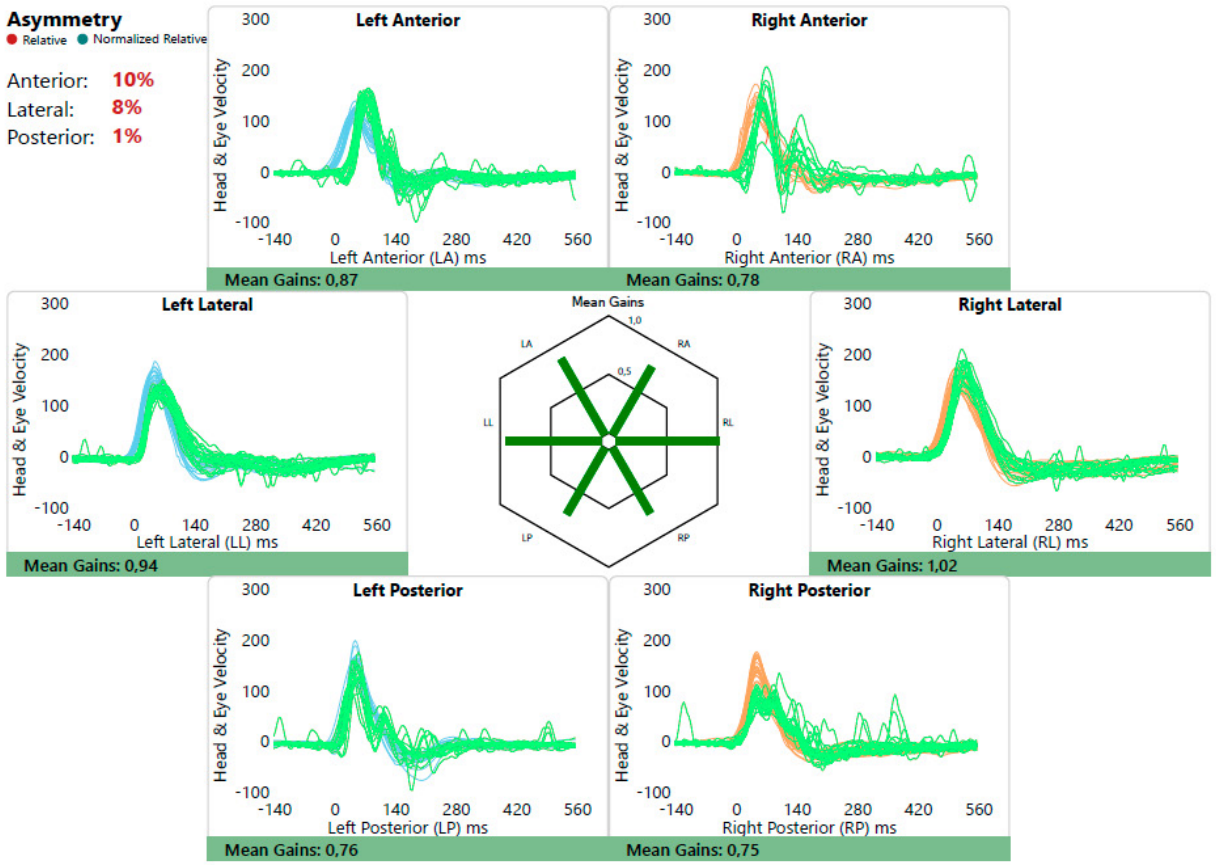

Figure 1: Graphical representation of the vestibulocular reflex gains of the six semicircular canals.

Table 1: Demographic informations

		Study group	Control group	Both
Age		10.5±3.5 (5-16)	9.3±3.9 (5-16)	10±3.6 (5-16)
Gender	**Male**	5	4	9
	Female	8	5	13
Number		13	9	22

(0.65-1.13); right posterior canal mean VOR-G value: 0.85±0.16 (0.7-1.24). Similarly, the VOR-G values obtained from the children in the control group were as follows: mean VOR-G of the left anterior canal: 0.84±0.11 (0.68-1); mean VOR-G of the right anterior canal: 0.84±0.13 (0.68-1.1); mean VOR-G of the left lateral canal: 0.89±0.1 (0.69-0.98); mean VOR-G of the right lateral canal: 0.94±0.17 (0.79-1.22); left posterior canal mean VOR-G: 0.90±0.18 (0.76-1.3); mean VOR-G of the right posterior canal: 0.86±0.15 (0.69-1.2). Left anterior canal and left lateral canal VOR-G values were significantly different between the groups (p=0.027 and p=0.007). No statistically significant difference was observed between the groups in terms of the mean VOR-G values of the right anterior canal, right lateral canal, left posterior canal, and right posterior canal (p=0.928, p=0.738, p=0.588, and p=0.780) (Table 2).

DISCUSSION

A number of standards have been defined as a result of V-HIT studies performed on healthy adult subjects (6, 7). However, the use of V-HIT in children with vertigo is relatively new, and

Table 2: Comparison of channel functions in the two groups

			Anterior		Lateral		Posterior	
Age	**n**		**Left**	**Right**	**Left**	**Right**	**Left**	**Right**
5-16	13	Study	0.75 (0.64–0.92)	0.85 (0.65–1.12)	0.77 (0.56–0.88)	0.96 (0.75–1.34)	0.86 (0.65–1.13)	0.85 (0.7–1.24)
5-16	9	Control	0.84 (0.68-1)	0.84 (0.68-1.1)	0.89 (0.69-0.98)	0.94 (0.79-1.22)	0.90 (0.76-1.3)	0.86 (0.69-1.2)
		p	*0.027*	0.928	*0.007*	0.738	0.588	0.780

one of the biggest concerns is the standardization of results. Studies have been conducted in recent years that help provide reliable information on the normal values of V-HIT in children (5, 8). Emekci et al. examined 100 adolescents aged 11-18 and did not find any significant age-related changes in VOR-G (8). In the study conducted by McGarvie et al., which also included children, it was shown that the normal values of VOR-G do not significantly change with age (6). However, in the study conducted by Bachmann et al., in which the adult and pediatric populations (<10 years) were compared, no age-related difference was observed within the pediatric population, but a significant difference was found between adult and pediatric subjects in terms of VOR-G values. Especially in the lateral canal VOR-G values, higher thresholds were found in children compared to adults. However, in all subjects, the VOR-G values of the right lateral canal were higher than those of the left side. The authors suggested this might be because the camera recorded the right eye during the test. In the same study, it was recommended to use lower thresholds for right anterior, left posterior plan (RALP) and left anterior, right posterior plan (LARP) VOR-G values in children compared to adults, in that the VOR-G values of these channels in children were found to be quite variable. This study was conducted on normal children under ten years of age and yielded valuable results; however, the small number of subjects included constitutes a limitation (5). In our study, V-HIT evaluation was performed in normal children without any complaints, as well as in children with vertigo. The small subject size, the broad age range, and unequal age distribution made the interpretation of the test results somewhat difficult.

In our study, when a total of 6 semicircular canals were evaluated, it was observed that the left anterior and left lateral canal gains were statistically lower in the pediatric dizziness group. Other channel gain averages were not significantly different between the patient and control groups. A possible reason for this could be that the cause of dizziness in this limited patient group might be due to a disease which does not affect some canal gains.

In many previous studies in the literature, while investigating the relationship between patient age and VOR-G, the subjects were divided into defined age ranges, and the differences between these groups were compared (5, 6, 8). In our study, however, it was impossible to place subjects into age categories due to the small number of patients and the non-homogeneous distribution of their ages.

Another concern with V-HIT is its test-retest reliability. In our study, the test was administered to each patient once, and the results were analyzed afterward. Singh et al. reported that the test-retest reliability of VOR-G and refixation saccades evaluated with V-HIT in both healthy individuals and individuals with vestibulopathy is high. These researchers demonstrated that both measurements were highly reliable and repeatable between the sessions, with the exception of vertical canal refixation saccades in some individuals and measurements in the affected ear in patients with vestibulopathy. In the study conducted by Singh et al., it was stated that inconsistent VOR-G results obtained between repeated measurements in individuals with vestibulopathy might be due to variable channel functions rather than inconsistency in repeated measurements (9). Mahfuz et al. reported no significant changes in VOR-Gs between repeated test applications (10). Therefore, the absence of repeated testing does not appear to be a significant limitation. However, it should be noted that variable values may be obtained between retests, and this may be due to changes in channel functions.

The advantages of the test are that it is both non-invasive and easy for the patient to cooperate with. It can also provide objective information about the semicircular canals. In this respect, it has significant advantages over the caloric test and the rotary chair (11). Khater et al. found that 84% of the children who were examined for dizziness and who had a normal caloric test result showed abnormal V-HIT findings, 13% of whom had lateral canal abnormality. Detection of abnormalities in one or both lateral canals despite normal caloric test results in 13% of children indicates that V-HIT is more sensitive than caloric testing in demonstrating lateral canal function. In addition, V-HIT stands out as an important and superior alternative to caloric test in children who cannot undergo this test due to external or middle ear pathologies and in children who cannot cooperate with the test (12). The youngest of the children in our study was five years old, and the oldest was 16 years old. None of the children had difficulties during the test. There are, however, some disadvantages of this test, such as device dependency, operator requirement, long testing times in some children, and the absence of specially-designed glasses for pediatric patients. The application can be complicated, especially in children with a small head and face, thin and slippery hair, and large pupils (5). Glasses can easily be fixed on the children's heads with simple bandages. However, the use of glasses designed for children will undoubtedly increase the applicability of the test.

CONCLUSIONS

Since it is challenging to evaluate dizziness in pediatric patients, V-HIT may be helpful in cases of clinical necessity. The non-invasiveness of the test is a significant advantage. Although it may be difficult for young children to comply with the test, it is generally well-tolerated. Hardware improvements, such as special eyeglasses designed for children, and increased experience can make the test more feasible.

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